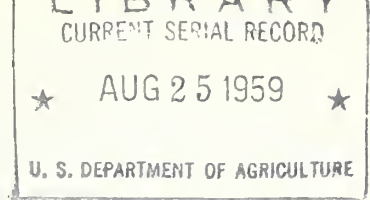


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

984Mw
p.4



MARKETING RESEARCH REPORT NO. 344

THE MARKET POTENTIAL FOR

COTTON LINTERS

AN ANALYSIS OF INDUSTRIAL USES OF AN AGRICULTURAL BYPRODUCT

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
MARKETING RESEARCH DIVISION

PREFACE

This study of the marketing of cotton linters is part of a program of marketing and utilization research designed to improve markets for agricultural products. The Market Development Branch, Agricultural Marketing Service, had primary responsibility for the conduct of the work and the preparation of the report. Personnel of the Southern Utilization Research and Development Division, Agricultural Research Service, participated in the planning phases and provided technical guidance. E. L. D'Aquin, E. A. Gastrock, and J. J. Spadaro, of the Southern Utilization Research and Development Division, gave valuable assistance in the study.

The information on characteristics of linters required for specific uses is intended to assist physical scientists in determining the type of technological research that will improve the quality of linters for each market outlet. Producers, dealers, processors, and end users are likely to find the information on linters for felting and chemical uses of aid in appraising the importance of these outlets.

Thanks are expressed to the cottonseed oil mills, linters marketing firms, linters bleachers, and end-use product processing firms for supplying information required for this study.

The study was conducted under the general direction of Marshall E. Miller of the Market Development Branch. Frank D. Barlow, Jr., supervised the conduct of field work and preparation of the manuscript.

CONTENTS

	Page		Page
SUMMARY	1	Market analysis--Continued	
Introduction	2	Foreign trade in linters.....	34
Objectives.....	2	Imports.....	34
Procedure.....	2	Exports	36
Definitions	3	Evaluation of market potential ..	38
Background.....	3	Factors affecting the mar-	
Historical data.....	3	ket potential of linters ...	39
Current situation.....	7	Felting uses	40
Market analysis.....	11	Selected chemical uses	41
Felting linters	12	Production and marketing	43
Trends in felting linters ...	12	Supply and distribution	43
Factors affecting the use of		Marketing and distribution.....	43
linters in felting mate-		Geographic production shifts and	
rials	14	related changes in linters	
Mattress felts and bedding .	16	production	44
Automobile felt	19	Oil mill practices	46
Commercial felters	20	Quality controls in producing	
Other uses of linters as a		linters	47
fiber.....	21	Linters sales	48
Chemical linters	24	Research needs and opportunities ...	49
Trends in chemical uses ...	26	Seed cleaning	49
Consumption and price.....	26	New equipment to remove	
Quality factors.....	26	linters from seed	51
Rayon and acetate	28	End-use product equipment.....	51
Nitrocellulose products	28	Chemical modification of	
Cellulose plastics	29	linters for chemical uses.....	52
Sausage casings.....	30	Chemical modification of	
Rag-content writing paper..	30	linters for use as a fiber	53

Issued July 1959

THE MARKET POTENTIAL FOR COTTON LINTERS

An Analysis of Industrial Uses of an Agricultural Byproduct

By Proctor Campbell and Richard Hall
agricultural economists, Market Development Branch

SUMMARY

The market potential for domestic felting linters is good. During the last several years, domestic production of felting linters has failed to equal domestic utilization by one-fifth to one-fourth of the amount used each year. Imports of high-quality felting grades have supplied the additional needs. The demand for felting linters is directly related to the demand for bedding, furniture, and automobiles, which are major outlets for such linters.

Chemical linters have experienced increased competition, primarily from dissolving woodpulp for use in rayon and acetate fibers, plastics, and explosives. Domestic supplies of chemical linters have been more than adequate to meet domestic demand at prevailing price relationships. It is estimated that less than one-fourth of the annual domestic production of chemical linters is reasonably safe from the quality-price competition of dissolving woodpulp, because of the increase of usable cellulose in the woodpulp resulting from improvements in cleaning and processing methods. Chemical linters pulp has technical and quality advantages over woodpulp in production of some high-quality products, but quality may be sacrificed for cost considerations when the price of linters pulp is high.

Rag-content writing paper is the most promising outlet for chemical linters. Recent industry estimates indicate that, potentially, linters may be substituted for up to 60 percent of the total cotton fiber in rag-content paper, provided technological improvements can be made in the strength of linters. At the 60 percent level of utilization and on the basis of 1952-57 production of rag-content paper, the market potential for linters in rag-content paper would be about 250,000 bales compared with annual use in the later 1950's of about 170,000 bales. The trend in use of rag-content paper, however, indicates a realizable potential closer to 210,000 bales annually in the near future.

Resiliency, good staple, and color are the most important characteristics desired for felting uses. Cleanliness is the most important characteristic for chemical linters. It is possible to improve the quality of both felting and chemical linters, however, by better cleaning of cottonseed before linters are removed from the seed, and by better cleaning of the linters after removal. This would more nearly satisfy the needs of both the users of chemical linters and of the felting trade. While cleaner linters are more important to chemical users of cellulose pulp than to users of felting materials, both of these markets are affected by the degree of cleanliness of linters. Felting users would like a larger volume of domestic linters with better staple and more resiliency. These characteristics cannot be improved upon by present-day mechanical means, although they can be adversely affected by improper handling.

Foreign trade is important to the market potential for domestically produced linters. Importation of felting linters has been necessary in recent years to satisfy domestic demand and maintain the position of felting linters in the domestic market. On the other hand, the export market has been one of the most important outlets for domestic chemical linters in the form of raw linters and purified cotton pulp. Exports of chemical linters in these forms averaged nearly 600,000 bales annually for the 5-year period 1952-56, and the prospect for export demand for chemical linters over the next few years appeared bright at price relationships prevailing in late 1958. Price was an important factor in the low volume of exports in 1957.

Price fluctuations for chemical and felting linters resulting from instability in production and supply plus high wartime demands for nitrocellulose and other military products of linters are not likely to be so wide in the future, because of technological improvements of competing products. Improvements in the production of dissolving woodpulp have made woodpulp more fully substitutable for linters pulp in the chemical production of more and more end-use products. And, since prices of dissolving woodpulp have been maintained at constant levels from 1951 to 1958, chemical linters prices will tend to stabilize at competitive levels.

Prices of felting linters will not tend to be stabilized to the same extent because of the absence of competitive raw materials having characteristics that enable such materials to replace linters in cotton felts. Foam rubber, foam plastics, rubberized hair, and wood fiber batting are competitive with cotton felt in bedding, furniture, and automobile cushions. However, the use of these materials is not expected to change materially in relation to use of cotton felt as long as sufficient supplies of linters are available and the price-quality relationship between these materials and cotton felt is maintained near the levels of the mid-1950's.

INTRODUCTION

Cotton linters are a versatile fiber used in the manufacture of many products. Chemical and felting uses account for almost all the domestic consumption. A small percentage of domestic consumption is in the manufacture of felt-based floor coverings and of battery boxes, medical supplies, and a few other miscellaneous outlets.

Chemical linters are used mainly in the manufacture of rayon and acetate fibers, plastics, explosives, paper, and sausage casings. The major felting uses are for bedding, automobile cushions, and upholstered furniture.

Production, marketing, and utilization of linters show marked instability over the years, and the instability of supply-demand relationships appears to affect market potentials adversely. The fact that cotton linters are only one of the four joint products of cottonseed, which is a byproduct of cotton lint production, is a major factor contributing to this instability.

Objectives

The overall objective of this study was to determine the market potential for linters in present and future end uses with a view to expansion of market outlets. Specific objectives of the project were (1) to determine the economic factors affecting the use of linters and competing materials in chemical and nonchemical end uses, and the reasons why competing materials have captured an increased share of markets formerly held by linters; (2) to determine physical and chemical properties needed by linters to increase their utilization in present and potential end uses; and (3) to determine research needs and opportunities for improving linters utilization in competitive markets.

Procedure

The evaluation of the market potential of linters in present and future end-use products was based upon (1) statistics collected from secondary sources on production, consumption, supply, and prices; and (2) results of a survey made in 1957 to obtain first-hand information on many aspects of linters production, marketing, and utilization.

Data on the amount of linters going into nonchemical uses were obtained from end users, including manufacturers of bedding, furniture, and felt for automobile cushions, and from commercial felters. Data on the amount of chemical linters needed and estimates of market potentials in various chemical end uses were obtained primarily from commercial bleachers. Officials of a representative number of paper firms were interviewed

to obtain information on the technical and economic requirements in utilizing linters in the production of rag-content writing paper.

Information on production and marketing practices, limitations, and problems was obtained from cottonseed oil mills and from linters dealers and brokers.

Definitions

Cotton linters. -- Cotton linters are the short fibers on the cottonseed, not removed by the cotton gin.

First-cut linters. -- When the linters fibers are removed from cottonseed by linter saws in two stages, those removed first are called first cuts or first-cut linters and are the longer fibers which are generally used in felting or uses of equal economic value.

Second-cut linters. -- Second-cut linters are the fibers removed by linter saws after the first cuts. This usually is the final step in the removal of linters from cottonseed.

Third-cut linters. -- A few oil mills in the Far West make a third cut of linters after second cuts have been removed.

Mill-run linters. -- Mill-run linters is the term applied when all of the linters to be removed are removed in one operation by linter saws.

Hull fiber. -- Hull fiber is the name of a fibrous material removed from the hulls of cottonseed by an abrasion process after the meats have been removed. Prior to the separation of the meats from the hulls either first-cut or mill-run linters are taken off the seed. Only a few mills produce hull fiber.

Felting linters. -- Felting linters are the linters used primarily by the felting trade. First cuts make up the bulk of these, but second cuts and mill-run linters also are used if resilient enough and satisfactory in staple.

Staple. -- Applied to linters, the term "staple" refers to the length distribution of the fibers and their resistance to separation.

Chemical linters. -- Chemical linters are those used in production by the chemical industry, which changes the structure of the linters fiber. Chemical linters are generally uses as cellulose rather than in the fibrous form produced by cottonseed oil mills.

Chemical cellulose or cellulose pulp. -- Chemical cellulose is the term applied to cellulose that is almost chemically pure. It may be produced from several cellulosic plants or fibers. Woodpulp is the major source of chemical cellulose, with linters second.

Bleachers. -- Bleachers is the term used for converters of chemical linters into cellulose pulp.

Cotton pulp. -- Cotton pulp is another name for chemical cellulose. It is used when it is desirable to indicate that linters are the raw material of the cellulose.

BACKGROUND

Historical Data

Uses for linters have been developed over many years, the major developments having taken place during and following World War I. For some years after development of the cottonseed crushing industry, linters were considered a waste product removed from cottonseed to facilitate processing of the seed into oil and meal. Before World War I, practically all linters produced were used by the mattress and upholstery trade. During

the early 1900's, the ratio of linters to cotton production was low and did not average more than 3 percent until 1909 (table 1).

With the beginning of World War I, demand for linters increased greatly because linters were the best source of raw cellulose for producing nitrocellulose for explosives. In 1916, the amount of linters produced was almost 10 times the amount produced in 1900 and was 11.6 percent of lint cotton production. From 1919 to 1923, production dropped almost to prewar levels because market outlets were again confined almost entirely to the mattress and upholstery industry. From 1923 to 1954, linters production gradually increased in ratio to cotton lint, reaching its highest point of 14.9 percent in 1954 (table 1). During the latest 5-year period (1953-1957), the ratio of linters to cotton dropped below 14.0 percent in only 1 year, when it was 13.9 percent in 1957.

TABLE 1.--Comparison of linters and cotton production, equivalent 500-pound bales, crops of 1900-1957

Year	Linters	Cotton	Ratio of linters to cotton	Year	Linters	Cotton	Ratio of linters to cotton
	<i>1,000 bales</i>	<i>1,000 bales</i>	<i>Percent</i>		<i>1,000 bales</i>	<i>1,000 bales</i>	<i>Percent</i>
1900.....	144	10,123	1.4	1929....	1,241	14,825	8.4
1901.....	166	9,510	1.7	1930....	986	13,932	7.1
1902.....	196	10,631	1.8	1931....	1,067	17,096	6.2
1903.....	194	9,851	2.0	1932....	912	13,002	7.0
1904.....	242	13,438	1.8	1933....	982	13,047	7.5
1905.....	230	10,575	2.2	1934....	1,001	9,637	10.4
1906.....	322	13,274	2.4	1935....	1,089	10,638	10.2
1907.....	268	11,107	2.4	1936....	1,407	12,399	11.3
1908.....	346	13,242	2.6	1937....	1,819	18,945	9.6
1909.....	310	10,005	3.1	1938....	1,378	11,944	11.5
1910.....	397	11,609	3.4	1939....	1,330	11,816	11.3
1911.....	558	15,693	3.6	1940....	1,507	12,565	12.0
1912.....	601	13,703	4.4	1941....	1,487	10,742	13.8
1913.....	639	14,156	4.5	1942....	1,705	12,820	13.3
1914.....	857	16,135	5.3	1943....	1,458	11,429	12.8
1915.....	931	11,192	8.3	1944....	1,551	12,230	12.7
1916.....	1,331	11,450	11.6	1945....	1,230	9,015	13.6
1917.....	1,126	11,302	10.0	1946....	1,221	8,640	14.1
1918.....	930	12,041	7.7	1947....	1,573	11,860	13.3
1919.....	608	11,421	5.3	1948....	2,025	14,877	13.6
1920.....	440	13,440	3.3	1949....	2,038	16,128	12.9
1921.....	398	7,954	5.0	1950....	1,428	10,014	14.3
1922.....	608	9,762	6.2	1951....	2,109	15,149	13.9
1923.....	669	10,140	6.6	1952....	3,121	15,139	14.0
1924.....	897	13,628	6.6	1953....	2,393	16,465	14.5
1925.....	1,115	16,104	6.9	1954....	2,039	13,696	14.9
1926.....	1,158	17,977	6.4	1955....	2,084	14,721	14.2
1927.....	1,016	12,956	7.8	1956....	1,860	13,310	14.0
1928.....	1,282	14,478	8.9	1957....	1,524	10,964	13.9

Source: Weekly Cotton Linters Review, May 16, 1958, U. S. Dept. Agr., Agr. Mktg. Serv., for 1939-1957, and "Cotton Production and Distribution," annual report of Bur. of Census for 1900-1938.

The rise in the relative level of linters production to cotton production was due primarily to the development of chemical uses for linters, which got their big stimulus in the middle 1920's as the primary source of cellulose in making acetate and rayon. Following World War I, experiments with linters pulp proved it superior to woodpulp for these products, because the linters pulp contained 95 percent cellulose compared to about 85 percent for woodpulp. But with the rapid growth of the rayon and acetate industry and the resulting technical improvements in purifying woodpulp, linters were not able to keep their position as the major source of cellulose, because linters production was dependent upon the size of the cotton crop. During the 1953-1957 period, linters accounted for only 12.2 percent of the cellulose pulp used by the rayon-acetate industry, woodpulp supplying the remaining 87.8 percent (table 2).

Concurrent with the decline in use of linters pulp by the rayon-acetate industry was the development of many other chemical cellulose products that could use linters. However, today linters pulp is superior to dissolving woodpulp for the production of only a few of these products, such as sausage casings and specialty cellulose plastics, and these market outlets can utilize only a small percent of the available supply of linters pulp.

TABLE 2.--Cellulose consumption by the rayon and acetate industry, 1930-1957

Year	Total pulp		Woodpulp		Linters pulp	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
1930.....	72	100	45	62	27	38
1931.....	84	100	53	63	31	37
1932.....	74	100	43	58	31	42
1933.....	115	100	65	57	50	43
1934.....	112	100	63	56	49	44
1935.....	137	100	36	63	51	37
1936.....	151	100	104	69	47	31
1937.....	176	100	132	75	44	25
1938.....	148	100	110	74	38	26
1939.....	195	100	145	74	50	26
1940.....	238	100	178	75	60	25
1941.....	283	100	215	75	73	25
1942.....	320	100	281	88	40	12
1943.....	337	100	281	83	56	17
1944.....	367	100	285	78	82	22
1945.....	400	100	297	74	103	26
1946.....	428	100	323	75	105	25
1947.....	473	100	397	83	81	17
1948.....	540	100	435	81	105	19
1949.....	477	100	349	73	128	27
1950.....	591	100	456	77	134	23
1951.....	616	100	516	84	101	16
1952.....	550	100	485	88	65	12
1953.....	589	100	522	89	67	11
1954.....	538	100	477	89	61	11
1955.....	635	100	547	86	88	14
1956.....	577	100	487	84	90	16
1957.....	566	100	517	91	49	9

Source: Textile Organon, January and March 1958.

Historically, linters for felting and other nonchemical uses have not experienced marketing problems resulting from the availability of low-cost competing raw materials with similar desirable characteristics. Instead, the marketing problems of linters for nonchemical uses have been due to insufficient supplies with corresponding increases in price.

Practically all linters used by the chemical industry are first converted by commercial bleachers into cellulose pulp. Second-cut linters are the principal raw material of the bleachers, though limited quantities of mill-run linters and cottonseed hull fiber also are utilized. During the 5-year period 1952-56, bleachers consumed a total of 4,391,000 bales of linters, a yearly average of about 60 percent of domestic consumption. The high year for bleacher consumption, in bales and percentage, was 1955. In that year, when the price was competitive with that for dissolving woodpulp, 1,110,000 bales were consumed, which accounted for 62 percent of total domestic linters consumption (table 3).

During the same 5-year period, the volume of domestic linters going to outlets other than bleachers ranged from a low of 516,000 bales in 1953 to a high of 679,000 bales in 1955 (table 3).

Consumption in the 1957-58 season was unusually low. In that year, consumption was about 8 percent below the 1952-56 average for other than bleachers, and almost 37 percent below the average for bleachers.

All cuts of linters are utilized for felting purposes. First-cut linters are the major supply source, but very limited quantities of mill-run and second-cut linters are used, usually in blends.

During the last 5-years, the ratio of production of each type of cut of linters to total production has been fairly consistent, first cuts accounting for about 24 percent of total production, second cuts about 71 percent, and mill runs about 5 percent (table 4).

TABLE 3.--Domestic linters consumption, in running bales, 1948-57¹

Year beginning August 1	Consumption by bleachers	Consumption by other than bleachers	Total consumption
	<i>1,000 bales</i>	<i>1,000 bales</i>	<i>1,000 bales</i>
1948.....	841	565	1,406
1949.....	968	648	1,616
1950.....	809	587	1,396
1951.....	800	506	1,306
1952.....	778	582	1,359
1953.....	808	516	1,324
1954.....	884	589	1,474
1955.....	1,110	679	1,789
1956 ²	811	625	1,436
1957 ²	550	550	1,100

¹ Data not available for prior years.

² Preliminary.

Source: Weekly Cotton Linters Review, May 20, 1958, U. S. Dept. Agr., Agr. Mktg. Serv.

TABLE 4.--Cotton linters production, in running bales, by type of cut, quantities and percentages, by seasons, 1940-57

Year beginning August 1	Quantities				Percentages			
	First cuts	Second cuts	Mill run	Total	First cuts	Second cuts	Mill run	Total
	<i>Bales</i>	<i>Bales</i>	<i>Bales</i>	<i>Bales</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
1940.....	324,914	681,617	201,398	1,207,929	26.9	56.4	16.7	100.0
1941.....	239,042	867,685	77,236	1,183,963	20.2	73.3	6.5	100.0
1942.....	29,690	137,901	1,187,606	1,355,197	2.2	10.2	87.6	100.0
1943.....	289,753	812,130	83,809	1,185,692	24.4	68.5	7.1	100.0
1954.....	239,340	942,888	68,686	1,250,914	19.1	75.4	5.5	100.0
1945.....	260,968	626,369	101,463	988,800	26.4	63.3	10.3	100.0
1946.....	291,022	567,008	133,838	991,868	29.3	57.2	13.5	100.0
1947.....	313,112	879,555	89,127	1,281,794	24.4	68.6	7.0	100.0
1948.....	387,287	1,164,535	87,345	1,639,167	23.6	71.1	5.3	100.0
1949.....	431,691	1,160,215	111,178	1,703,084	25.3	68.2	6.5	100.0
1950.....	345,424	797,717	82,818	1,225,959	28.2	65.0	6.8	100.0
1951.....	426,912	1,209,365	111,266	1,747,543	24.4	69.2	6.4	100.0
1952.....	440,223	1,222,373	114,049	1,776,645	24.8	68.8	6.4	100.0
1953.....	473,061	1,400,409	110,616	1,984,086	23.8	70.6	5.6	100.0
1954.....	376,940	1,203,515	101,147	1,681,602	22.4	71.6	6.0	100.0
1955.....	398,704	1,199,476	89,391	1,687,571	23.6	71.1	5.3	100.0
1956*.....	350,780	1,075,475	69,454	1,495,709	23.5	71.9	4.6	100.0
August-May								
1956*.....	331,918	1,019,610	65,799	1,417,327	23.4	71.9	4.7	100.0
1957*.....	280,766	817,990	74,957	1,173,713	23.9	69.7	6.4	100.0

*Preliminary.

Source: Weekly Cotton Linters Review, July 11, 1958, U.S. Dept. Agr., Agr. Mktg. Serv.

The historical patterns of linters consumption were interrupted during the two World Wars and the Korean conflict because of the demand for large quantities of linters for making nitrocellulose and other military products. These wartime demands for linters, plus the rigidity of production, resulted in higher prices for linters than was normal for the historical uses. Table 5 gives the average yearly price per pound of linters for the years 1930 to 1956 for selected grades, based on the official standards for American cotton linters in use prior to July 1, 1956. Linters in grades 2 and 4 usually went into nonchemical uses and linters in grade 6 into chemical uses.

Current Situation

Importance of Cotton Linters

During the 5 seasons 1953-57, production of cotton has been sufficient for cottonseed oil mills to process almost 5 million tons of seed annually. In the same period, cash receipts from marketing cottonseed have averaged approximately \$300 million annually.

The value of cottonseed products produced in the 1946-57 period varied from \$331 million to over \$565 million. The value of the joint products of cottonseed over the 5 seasons 1953-57 averaged \$227 million for oil, \$154 million for meal, \$43 million for linters, and \$12 million for hulls. Linters represented about 10 percent of the average value of all cottonseed products during the 5 seasons 1953-57.

Annual variation in the value of linters from 1946 to 1957 has been substantial, ranging from a low of \$34 million in 1957 to over \$115 million during the Korean conflict in 1950 (table 6).

TABLE 5.--Average yearly price per pound of linters for selected grades, 1930-1955¹

Year beginning August 1	Price per pound		
	Grade 2	Grade 4	Grade 6
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
1930.....	3.59	2.05	1.24
1931.....	2.52	1.31	.83
1932.....	2.52	1.52	1.04
1933.....	5.10	3.93	3.25
1934.....	5.71	4.65	4.00
1935.....	5.49	4.42	3.43
1936.....	5.80	4.64	3.79
1937.....	3.59	2.48	1.66
1938.....	3.37	2.14	1.28
1939.....	4.63	3.41	2.62
1940.....	5.31	4.19	3.13
1941.....	9.83	7.20	3.50
1942.....	9.74	7.07	3.50
1943.....	7.18	4.88	3.06
1944.....	7.17	5.01	3.21
1945.....	7.25	5.12	3.79
1946.....	11.71	9.30	8.22
1947.....	9.71	7.24	5.73
1948.....	7.89	4.65	2.85
1949.....	10.49	6.76	3.61
1950.....	22.00	17.19	14.19
1951.....	12.50	8.93	7.41
1952.....	12.00	7.04	4.33
1953.....	10.30	5.29	3.22
1954.....	8.17	4.55	2.77
1955.....	8.06	4.35	2.71

¹ See table 8 for average monthly prices for selected grades under the new grade standards and for selected months from August 1956 to July 1958.

Source: Statistical Bulletin No. 99, U. S. Dept. Agr., Agr. Mktg. Serv.

The \$34 million indicated for the 1957-58 production of linters is the lowest value for any linters crop in the last 12 years or more. In the 1956-57 season, the value was \$47.2 million and the 1953-57 average was \$43.3 million.

Production and Consumption

During the 5 years 1953-57, the annual average supply, disappearance, and carry-over stocks were higher than in any other 5-year period in the history of linters, at 3,047,000 bales supply, 1,775,000 bales disappearance, and 1,139,000 bales carryover (table 7). These high totals are the result of exceptionally high production of linters from 1951 through 1957, due to high production of cotton and cottonseed in these years, together with increased percentages of total cottonseed production crushed and a higher than average cut of linters per ton of cottonseed. After 1954, when carryover stocks were the highest on record at 1,543,000 bales, carryover stocks were gradually reduced, with total disappearance greater than production in each year from 1953 to 1957. Carryover stocks as of August 1, 1958, were approximately 810,000 bales.

TABLE 6.--Cottonseed products: Value of all products compared with linters,
1946-57 seasons¹

Season beginning August 1	Value of all cottonseed products	Value of linters	Linters as percentage of total
	<i>Million dollars</i>	<i>Million dollars</i>	<i>Percent</i>
1946.....	410.4	57.8	14.1
1947.....	565.4	52.8	9.3
1948.....	460.8	39.9	8.7
1949.....	458.3	58.6	12.8
1950.....	500.2	115.8	23.2
1951.....	550.3	91.6	16.6
1952.....	549.0	62.5	11.4
1953.....	542.5	54.8	10.1
1954.....	458.3	40.2	8.8
1955.....	435.1	39.0	9.0
1956.....	411.2	47.2	11.5
1957.....	330.7	34.0	10.3

¹ Calculated from official statistics of the U. S. Dept. of Agr. and Bureau of the Census.

A large part of the 1953, 1954, and 1955 carryover of linters was in Commodity Credit Corporation stocks acquired in 1951 through 1954 under the cottonseed price support programs. Commodity Credit Corporation stocks accounted for 65 to 80 percent of the carryover in 1953 to 1955. The liquidation of these stocks which began in July 1955 was completed in July 1957.

Prices

Prices of both felting and chemical linters have fluctuated considerably since August 1956 (table 8). In August 1956, prices of high- and medium-grade felting linters averaged 8.01 cents and 4.53 cents per pound, respectively, and chemical linters 2.82 cents per pound. From this point, prices increased to a high in February and March 1957 of 10.0 cents and 7.52 cents per pound for high- and medium-grade felting linters, while the high of 5.31 cents per pound for chemical linters was reached in February 1957. After this, prices started down again and the December 1958 average monthly prices of 8.11 cents and 5.21 cents per pound, respectively, for high- and medium-grade felting linters were approximately 2 cents per pound lower than the 1957 highest average prices. The average price for chemical linters in December 1958 was almost 3 1/2 cents per pound below the 1957 highest average price, and thus back in price competition with dissolving woodpulp.

Prices of purified linters pulp have fluctuated in line with the raw chemical linters market, which is influenced by the variation in the size of the cotton crop, demand by commercial bleachers, and the export market (table 9). In contrast, dissolving woodpulp prices have remained constant since 1951 at 9.25 cents per pound for standard viscose grade, 9.75 cents per pound for high-tenacity viscose grade, and 11.25 cents per pound for acetate and cuprammonium grade.

The prices of synthetic rubber, noncellulosic plastics, and other substitutes for linters or products made from linters, have also shown considerable uniformity over the last 5 years. In addition, capacity for producing these competitive materials has been greatly increased, and greater strides have been made in improving the technology and processing of these materials.

TABLE 7.--Production and consumption of linters as related to cotton and cottonseed production, 1940-1958

Season beginning August 1	Cotton production	Cottonseed production	Percentage of cottonseed production crushed	Out of linters per ton of cottonseed	Linters production	Total supply of linters	Total disappearance of linters	Carryover stocks August 1
	1,000 bales ²	1,000 tons	Percent	Pounds	1,000 bales ³	1,000 bales ³	1,000 bales ³	1,000 bales ³
1940.....	12,566	5,595	78.6	165	1,208	2,166	1,381	706
1941.....	10,744	4,788	83.7	179	1,184	2,165	1,525	787
1942.....	12,817	5,717	78.7	183	1,355	2,071	1,331	637
1943.....	11,427	4,680	84.5	179	1,186	1,999	1,429	739
1944.....	12,230	4,902	86.8	176	1,251	2,017	1,523	567
1945.....	9,015	3,663	89.1	182	993	1,587	1,078	379
1946.....	8,640	3,511	88.0	191	995	1,509	1,037	422
1947.....	11,860	4,683	87.2	186	1,288	1,772	1,391	337
1948.....	14,877	5,943	89.7	183	1,646	2,131	1,599	370
1949.....	16,128	6,614	86.4	176	1,710	2,405	1,806	495
1950.....	10,014	4,105	90.7	185	1,244	1,800	1,489	452
1951.....	15,149	6,302	86.9	185	1,767	2,144	1,534	264
1952.....	15,139	6,191	89.9	184	1,799	2,688	1,468	543
1953.....	16,465	6,749	92.7	184	2,003	3,278	1,563	1,111
1954.....	13,696	5,709	91.9	187	1,682	3,410	1,755	1,543
1955.....	14,721	6,043	92.5	180	1,688	3,382	2,185	1,491
1956.....	13,310	5,407	91.3	181	1,496	2,668	1,773	1,025
1957 ¹	10,964	4,609	91.7	176	1,246	2,209	1,284	824
1958 ¹	12,105	5,008	--	--	--	--	--	810

¹ Preliminary, partly estimated.² Bales of 500 pounds gross weight.³ Running bales.Source: Compiled from tables 32, 56, and 57 in The Cotton Situation, GS-173, November 1957, and Weekly Cotton Linters Review, Sept. 12, 1958, U.S. Dept. Agr., Agr. Mktg. Serv.

TABLE 8.--Monthly average prices of linters for specified qualities, in cents per pound, August 1956-December 1958¹

Month and season	Felting linters		Chemical linters	
	High grade	Medium grade	73 percent cellulose	Cellulose differential ²
<u>1956</u>				
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
August.....	8.01	4.53	2.82	.05
September.....	8.69	4.63	2.85	.05
October.....	8.85	4.86	3.08	.05
November.....	8.98	5.45	3.83	.06
December.....	9.41	6.39	4.75	.06
<u>1957</u>				
January.....	9.83	7.10	5.17	.07
February.....	10.00	7.42	5.31	.07
March.....	10.00	7.52	5.28	.07
April.....	9.12	7.37	5.26	.07
May.....	9.06	7.19	5.07	.07
June.....	8.84	7.01	4.71	.07
July.....	8.83	7.14	4.44	.06
August.....	9.13	6.94	4.24	.06
September.....	9.22	6.88	3.84	.05
October.....	8.82	6.38	3.14	.04
November.....	8.38	6.23	3.10	.04
December.....	8.72	6.47	3.20	.04
<u>1958</u>				
January.....	8.75	6.52	3.22	.04
February.....	8.66	6.36	3.22	.04
March.....	8.38	6.31	3.22	.04
April.....	8.38	6.31	3.22	.04
May.....	8.38	6.13	3.18	.04
June.....	8.38	6.06	3.16	.04
July.....	8.25	5.95	2.97	.04
August.....	8.16	5.74	2.54	.04
September.....	8.42	5.56	2.42	.03
October.....	8.42	5.50	2.41	.03
November.....	8.40	5.34	2.17	.03
December.....	8.11	5.21	1.97	.03

¹ Monthly average prices quoted at Atlanta, Memphis, Dallas, and Los Angeles for linters, uncompressed, in carlots f.o.b. cottonseed oil mill points excluding ports.

² Premiums and discounts for each one percent change in cellulose content.

Source: Weekly Cotton Linters Review, U. S. Dept. Agr., Agr. Mktg. Serv.

MARKET ANALYSIS

Historical data on linters consumption (table 3) show that for the 1948-57 period, the relative percentages of felting linters and chemical linters consumed domestically were rather stable, felting linters accounting for approximately 39 percent of total domestic consumption and chemical linters for the remaining 61 percent. Of the total linters produced in recent years, over 70 percent have been second cuts, 5 to 7 percent mill runs,

TABLE 9.--Average prices for chemical linters and purified linters in cents per pound, selected months, 1952-58

Month and year	Chemical linters	Purified linters	Dissolving woodpulp		
			Standard viscose	High-tenacity viscose	Acetate and cupra
	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>
July 1952.....	6.97	15.80	9.25	9.75	11.25
July 1953.....	3.91	11.85	9.25	9.75	11.25
July 1954.....	3.00	10.50	9.25	9.75	11.25
July 1955.....	2.54	9.75	9.25	9.75	11.25
January 1956.....	2.77	10.15	9.25	9.75	11.25
April 1956.....	2.84	10.50	9.25	9.75	11.25
July 1956.....	2.81	10.50	9.25	9.75	11.25
October 1956.....	3.14	12.00	9.25	9.75	11.25
January 1957.....	5.17	13.90	9.25	9.75	11.25
April 1957.....	5.26	13.90	9.25	9.75	11.25
July 1957.....	4.44	13.90	9.25	9.75	11.25
October 1957.....	3.14	12.00	9.25	9.75	11.25
January 1958.....	3.22	12.00	9.25	9.75	11.25
April 1958.....	3.22	12.00	9.25	9.75	11.25
July 1958.....	2.97	12.00	9.25	9.75	11.25

Source: Weekly Cotton Linters Review, Sept. 19, 1958, U. S. Dept. Agr., Agr. Mktg. Serv.

and some 22 to 25 percent first cuts (table 4). Sizable quantities of high-quality, long-staple, first cuts for the felting trade are imported each year, while even larger quantities of chemical-grade linters are exported either as raw linters or as purified pulp. The quantities of cotton linters used for each major end use, as well as the relative importance of these uses in the domestic consumption pattern for the years 1948-55, have been summarized from the Cotton Linters reports published by the National Cotton Council, and are presented in table 10.

Felting Linters

Trends in Felting Linters

While felting linters have accounted for an average of 39 percent of total domestic consumption of linters, year-to-year variations have ranged from 38.7 percent in 1951-52 to 50 percent in 1957-58 (table 3).¹

Mattress felts and bedding materials are the most important outlets for felting linters. Use in these products rose slightly from some 15 percent of the total linters consumed domestically during the 4-year period 1948-51 to slightly more than 18 percent in the 1952-55. For many years automobile batts and padding have been the second most important outlets for felting linters. This market declined from 12.6 percent in 1948 and 13.1 percent in 1950 to 9 percent of the total market in 1955, mainly because of increased use of foam rubber in automobile seats. The use of felting linters in furniture stuffing and padding declined from nearly 10 percent of the total domestic market for linters in 1948 to less than 5 percent in 1955.

The volume of felting linters used in making paper more than tripled from the equivalent of 15,000 bales in 1948-51 to some 48,000 bales in 1955, and accounted in 1955 for slightly more than 2 percent of total domestic linters consumption.

¹Chemical linters consumption declined precipitously in 1957-58 relative to felting linters because chemical linters prices were beyond competitive levels with dissolving woodpulp for all of 1957 and early 1958.

TABLE 10.--Cotton linters: Estimated domestic consumption and disappearance, in 500-lb. bales, by major uses, 1948-1955¹

Uses	Consumption (years beginning August 1) ²								Percent of total consumption							
	1948	1949	1950	1951	1952	1953	1954	1955	1948	1949	1950	1951	1952	1953	1954	1955
CHEMICAL LINTERS	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales								
Rayon and Acetate, total.....	556	621	576	437	356	337	391	582	32.2	31.5	35.5	27.9	22.1	21.2	22.0	26.6
Viscose and cupra.....	309	377	310	304	318	286	305	445	17.9	19.1	19.1	19.4	19.7	18.0	17.2	20.3
Acetate.....	247	244	266	133	38	51	85	137	14.3	12.4	16.4	8.5	2.4	3.2	4.8	6.3
Nitrocellulose products, incl. explosives and film.....	88	112	89	120	229	173	163	134	5.1	5.7	5.5	7.6	14.2	10.8	9.2	6.1
Plastics, incl. cellulose acetate and butyrate.....	110	142	106	66	92	81	77	112	6.4	7.2	6.5	4.2	5.7	5.1	4.3	5.1
Paper ³	50	61	45	27	46	65	85	120	2.9	3.1	2.8	1.7	2.9	4.1	4.8	5.5
Sausage casing.....	18	30	26	26	44	43	42	58	1.0	1.5	1.6	1.7	2.7	2.7	2.4	2.7
Cellulose ethers.....	34	52	45	27	46	41	40	44	2.0	2.6	2.8	1.7	2.8	2.6	2.2	2.0
Total, domestic consumption	856	1,018	887	703	813	740	798	1,050	49.6	51.6	54.7	44.8	50.4	46.5	44.9	48.0
Exports of refined pulp.....	199	188	68	280	130	247	287	318	11.5	9.6	4.2	17.9	8.1	15.5	16.1	14.5
TOTAL CONSUMPTION.....	1,055	1,206	955	983	943	987	1,085	1,368	61.1	61.2	58.9	62.7	58.5	62.0	61.0	62.5
FEELING LINTERS																
Mattress felts and bedding.....	242	257	282	271	268	280	332	411	14.0	13.0	17.4	17.2	16.6	17.6	18.7	18.8
Automotive batts and padding....	218	226	212	136	175	164	202	200	12.6	11.5	13.1	8.7	10.8	10.3	11.3	9.1
Furniture stuffing and padding....	168	192	133	117	113	78	83	94	9.8	9.7	8.2	7.4	7.0	4.9	4.7	4.3
Paper ³	12	12	6	28	30	32	39	48	0.7	0.6	0.3	1.8	1.9	2.0	2.2	2.2
Other nonchemical uses ⁴	31	79	34	34	84	51	38	67	1.8	4.0	2.1	2.2	5.2	3.2	2.1	3.1
Total, domestic consumption....	671	766	667	586	670	605	694	820	38.9	38.8	41.1	37.3	41.5	38.0	39.0	37.5
GRAND TOTAL.....	1,726	1,972	1,622	1,569	1,613	1,592	1,779	2,188	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

¹ Based on trade estimates.

² Converted to 500-pound gross-weight bales based on annual weight per running bale, second-cut linters.

³ Includes fine writing paper, absorbent paper, insulating paper, vulcanizing paper, etc. Also includes an undetermined quantity of first cuts, mill runs, and full fiber. Excludes linters processes in paper mills.

⁴ Includes boxes for storage batteries, linoleum (includes all felt-backed floor covering), yarn, and medical supplies.

Source: Compiled from National Cotton Council Cotton Linters reports, January 1954 and December 1956.

Other nonchemical uses include a wide variety of miscellaneous uses such as those for batting for fireproof decorative purposes, insulation, absorbent fillers for low-grade hospital surgical dressings, stuffing for low-cost items such as cot pads and glider cushions, and fillers in the manufacture of linoleum and battery boxes. These uses accounted for about 3 percent of total linters consumption in 1955. The qualities used in these products range from low-quality second cuts to high-quality first cuts, with price usually the principal factor determining the use in low-value items.

Factors Affecting the Use of Linters in Felting Materials

Linters and cotton waste are the basic raw materials for producing cotton felt, though staple cotton is used to a limited extent. Cotton felt is made by garnetting linters and waste or staple cotton together. Linters give felt the characteristic of resiliency, while the longer fibers of cotton waste and staple cotton give the felt strength, and bond it together. Felt has been made with linters as the only material. However, linters fibers are too short to produce a strong felt. Cotton waste and staple cotton used alone are too soft, and lack the desired resiliency for most purposes. A combination of linters and waste is generally preferred. Even so, cotton waste is often used alone for felting purposes, because strength is more desirable than resiliency in certain uses. Staple cotton is seldom used, except for specialty purposes, because of its high cost in relation to cotton waste. The highest priced cotton felt is made from highest quality cotton waste or staple cotton, with a low percentage of linters or no linters.

The primary uses of cotton felt having linters as one of the basic raw materials are in mattresses, box springs, sofa beds, couches, upholstered furniture, and automobile seat and back cushions. The felt is used to a limited extent in quilts, mattress pads, playpen pads, baby-buggy pads, and other miscellaneous items.

Manufacturers of bedding, whose products include mattresses, box springs, couches, and daybeds, generally garnett their own cotton felt. A few of the smaller firms buy the cotton felt they use. Manufacturers of upholstered furniture and producers of quilts, playpen pads, and other miscellaneous items generally buy their cotton felt from commercial felters. Automobile manufacturers contract for their cotton felt, to be made to specifications by firms specializing in making felt for automobile seat and back cushions.

The competitive relationships between cotton waste materials and linters are reflected in the substitutability of linters and cotton waste. This substitution factor causes commercial felters to change mixes of fibers in response to price changes of the fibers included in the blend. However, the complementary quality factors of the longer fibers of cotton waste and the resiliency of linters limit the substitution of one fiber for the other in response to relative price changes.

The comparative importance of substitution because of price and of the complementary utility factors varies according to the desired end product. The limitations to substitution have become important in the marketing of cotton felts and batting as competing materials have been introduced in products formerly made almost exclusively from the cotton products. The growing importance of the complementary factors is more easily understood in terms of the limitations to substitution:

1. Linters are used primarily in felts and batts because of their "harsh" character, which imparts loft, bounce, or resiliency to cotton felts and batting. Ordinary cotton fibers and cotton waste fibers are longer in staple, act as a binding agent, and are comparatively soft.
2. Linters are relatively short in staple in comparison with cotton waste fibers, sisal, and other fibers used in making batting. In garnetting a felt or batting to obtain strength and cohesiveness of the felt or batting, staple is important.
3. Color is a quality characteristic often considered in determining the purchase value of felt for use in producing consumer goods. Most felting linters are

more deeply colored (cream or buff) than the cotton fiber removed from the same plant. Good color in linters is also considered an indication of cleanliness. Therefore, in many evaluations for end-use products, cleanliness and color as characteristics are not considered individually.

4. In-plant production specifications, necessitated by production rates, garnetts installed, and end products desired, limit adjustments in fiber mixes.
5. A firm's reputation for a particular quality of product also limits adjustments in mixes of fibers in response to price changes.
6. Government specifications and label requirements in some States limit substitutions in some end-use products.

Dealers and end users interviewed indicated that "harshness", (resiliency), staple, color, and cleanliness were the four most important factors in selecting the quality of linters desired for mattresses. Cleanliness is the least important of the four, because practically all felting linters are cleaned sufficiently by the oil mills for most felting uses. The pricing mechanism in the market attempts to strike a mean value for all four quality factors combined. Reasons for the limited potential use of linters in present-day products are related to the limited supply of linters and the lack of the combination of desirable quality characteristics at prices manufacturers consider favorable for continued and increased use. End-user concern over the quality of linters available is apparently due to three factors, which have changed over the last two decades:

1. With modern gin practices, practically all cotton lint fibers are removed from the seed, leaving a smaller percentage of these lint fibers to be removed with the linter fibers.
2. Since the weight of linters removed per ton of seed has increased, it is believed that more short fibers and perhaps additional hull fragments are being cut from the seed.
3. Linters are produced today under greatly improved gin practices and might be considered "overprocessed" in comparison with the product of former methods of handling linters in harvesting, ginning, and cleaning operations.

The Nickerson-Hunter colorimeter can measure the color of linters very accurately, and the fibrograph appears to provide an excellent measure of staple. There is no fully proved method for measuring the resiliency and compressibility of linters, but the compressometer is being tested to determine if it will provide an accurate measure of this character.

Harshness. -- This characteristic refers to the resiliency or loft which can be obtained in a felt. The degree of harshness, or resiliency varies by production area and is influenced by variances in a growing season and in variety. Production of relatively harsh linters is concentrated in the southwestern and western production areas. This characteristic is affected also by harvesting and processing conditions. Production of the Rowden variety, grown in northeast Texas, which is considered to produce the linters most desirable from the standpoint of harsh characteristics, has been declining.

Staple. -- Experience indicates that the longest linters fibers, used alone, are inadequate for use on garnetts for quality felts or mattresses.

Color and cleanliness. -- In commercial felt, color is recognized as an important quality characteristic. In products which are garnetted, some types of foreign matter such as dirt are removed, whereas longer pieces of trash remain in the felt or batting. Cotton waste fibers are used not only because of their longer staple, which binds the linters in garnetting, but also to improve the color of the finished product. Intrinsic color of linters

apparently does not affect other quality characteristics such as resiliency, staple, and cleanliness of end products, but the degree of cleanliness does affect the evaluation of end-product quality.

A complication in determining potential use of linters in mattresses and related products is the fact that the consumer purchases the end product on the basis of price because he has no measure of quality of the product. He can measure its usefulness only over a period of actual use; if utility is high, he will buy again, and if not, he will buy something different. Adequate measures of mattress utility as related to fiber characteristics or cost do not exist. Such measures were not needed in the past and are not vital in today's market. The widening range of choice offered the consumer in selecting products made from different materials probably will require manufacturers to devise methods to measure utility, in order to promote their products more effectively. The alternative is continued emphasis on the price advantage of cotton felting materials, which probably will continue to narrow as improvements are made in competitive materials.

Mattress Felts and Bedding

The trend in use of linters in mattress felts and bedding since 1948 has been upward. It has been estimated that over 370,000 bales of linters were used annually in bedding in 1955 and 1956, compared with an average of 260,000 bales from 1948 through 1950. Consumption in 1957-58 was reported to be about 15 to 20 percent below the annual rate of 370,000 bales. The relatively high utilization of linters in 1955-57 was due largely to an increase in domestic purchases of bedding products. However, changes in the competitive market for fibers also have been a factor.

The following generalizations are indicated from information furnished by bedding firms. The amount of linters used by different manufacturers in felts for bedding ranged from a low of 12 percent to a high of 90 percent, with a weighted average of 65 percent. The other 35 percent of materials consisted of various types of cotton waste--mostly picker, fly, strips, cotton mill motes, and cotton gin motes. About one-fourth of the bedding firms supplying information used less than 50 percent linters in their felting mix, about half used from 50 to 75 percent linters, and the remaining one-fourth used 75 percent or more. Felts containing the highest percentages of linters are generally used in the best quality bedding. The linters in these felts is usually of the higher grades.

Over half of the bedding manufacturers did not know the quality of the linters used in their products in terms of U. S. standards for cotton linters. However, the price quoted by these firms as the price paid for linters bears out their contention that they use high-quality linters. Generally, medium to highest priced cotton wastes are used in the better quality bedding felts. But price is not necessarily a good measure of the value of waste for this purpose. Some users consider certain kinds of the lower priced wastes to be as good or better for garnetting with linters as the higher priced wastes. This is especially true when color is not important.

About one-fourth of the bedding manufacturers used one standard mix for garnetting the felt used in their products, and three-fourths of the firms used two or more mixes, with each mix used for specific products.

There is no one outstanding factor that governs the exact percentage of linters to waste in felting mixes for bedding. Most of the firms have been using the same formulas for many years and seldom change. About a third of the firms gave price relationships between linters and waste as the factor that governs the percentage of each fiber used, and over 80 percent of the firms gave price as the factor that would cause a change in the ratio of linters to waste. However, since the prices of linters and cotton waste generally move together, the price relationship seldom changes enough to cause a change in a specific mix. The price relationship would have to change a cent a pound or more before there would be an appreciable change in the percentage of linters used, and the substitution then would be only partial. About a third of the firms gave "quality of felt desired" as another factor governing the ratio of linters to cotton waste in each mix, with price

relationship as a secondary factor. Other factors mentioned which control the felting formulas were specifications for products produced under Government contract, State labeling laws on minimum requirements, quality and character of linters available, and experience over several years.

Less than 10 percent of the firms thought cotton waste could be substituted entirely for linters, and then only for limited end uses. About 10 percent of the firms stated they would not substitute waste for linters unless linters were not available at any price. These firms would use 100 percent linters in their felting if linters had sufficient staple length. Resiliency was named by 80 percent of the firms as the primary characteristic desired of linters for bedding, and staple as the second most important characteristic. The other two characteristics, color and cleanliness, were considered to be not nearly as important as resiliency and staple.

Most firms, particularly the volume users, stated that linters are not lacking in desired characteristics. A few firms would like linters to have longer fibers to aid garnetting. However, the lack of linters with longer fibers is not considered a serious felting problem because cotton waste has sufficient staple length to hold the shorter linters fibers together. Linters need the longer fibers of cotton waste, and cotton waste needs the resiliency of linters for making the best cotton felts for bedding.

During 1956-57, bedding firms paid from 6.5 cents to 12 cents per pound for linters. The actual price paid varied because of time of year, location, grade, and resiliency. In comparison, prices for cotton waste ranged from 3 1/4 cents to 18 cents per pound, depending upon the kind and quality of waste. Following are examples of prices paid per pound for different kinds of cotton waste in 1957:

Cotton mill sweeps.....	3-1/4 cents
Cotton oil mill notes.....	3-1/2 to 5-1/2 cents
Cotton gin notes.....	5-1/2 to 6 cents
Cotton mill notes.....	7 cents
Picker waste	8-3/4 to 11 cents
Willow waste	11 cents
Fly	11 to 12 cents
Vacuum strips	17-1/2 to 18 cents
Unclassified cotton waste	11 to 17 cents

No attempt was made to determine the comparative costs of linters and cotton waste in bedding felts. Price comparison is not an accurate method of determining the comparative costs, because of the difference in handling and in the percentage of usable fibers per bale of each product.

Estimates of the cost of bedding felt during 1956-57, which include all labor and processing costs through the garnetting process, ranged from 10 cents per pound to 20 cents. The range in amount of felt per mattress was from 20 pounds to 45 pounds in mattresses using felt as the only padding material.

Consumers like a resilient surface in their bedding for comfort, and linters is still the cheapest material that can be used in cotton felt having the desired resiliency. Cotton waste cannot be substituted for linters in bedding felt above a certain percentage without lowering resiliency. The minimum amount of linters desirable for maintaining resiliency is from 30 percent to 50 percent in each felting mix, and most manufacturers appear to resist any substitution. Cotton waste would have to gain a sizable price advantage over linters before the cost of felting materials could be lowered appreciably by substituting waste for linters. A 2-cent price advantage in substituting 20 pounds of waste for linters would lower the cost 40 cents. The maximum substitution per mattress would be about 40 pounds, which, with a price advantage of 2 cents, would lower costs 80 cents; and with a 3-cent price advantage, \$1.20. These substitutions could not be made without lowering the quality of the bedding and therefore the price received for the particular unit. Once a manufacturer establishes his products in a market, he seldom changes the raw materials

used unless the market changes or unless substitute materials are developed that are as good or better at a price advantage. But once a change in raw materials is made, a change back to the original materials is difficult of accomplishment.

The substitution factor appears more important when linters and waste fiber prices vary inversely for particular grades or qualities. This situation is illustrated in table 11. Substitution of the relatively inexpensive for the more expensive fiber in this situation changes the volume of a particular fiber, and the cost of the particular unit. In actual markets, general economic conditions usually cause linters prices to fluctuate directly with, rather than inversely to, waste fibers.

Resilient fibers that could be used as substitutes for linters in felt for bedding are too expensive or have other characteristics that exclude them from use for bedding. Horsehair and wool have a high resiliency plus fiber length, but are too expensive. Synthetic fibers such as lofted acetate, dacron waste, acetate waste, and acrylic waste have a high degree of resiliency and can be purchased in any fiber length, but are too light and too expensive for general use in bedding. Glass fiber has been considered as a substitute for cotton felt, but it is more expensive and it is not known if it will retain its resiliency for a long time when used in bedding.

TABLE 11.--Cost of fiber in a 40-pound mattress using selected prices and mixes

Types of mattresses	Low price and quality mix	Average price and quality mix	High price and quality mix
1. Different qualities and costs			
Percentage of linters used per unit....	40%	60%	80%
Weight of linters per mattress.....	16 lbs.	24 lbs.	32 lbs.
Price per lb. of linters.....	6.5¢	9¢	12¢
Cost of linters per unit.....	\$1.04	\$2.16	\$3.84
Percentage of cotton waste fiber used..	60%	40%	20%
Weight of waste fiber.....	24 lbs.	16 lbs.	8 lbs.
Price of waste fiber per lb.....	6¢	12¢	18¢
Cost of waste per unit.....	\$1.44	\$1.92	\$1.44
Total fiber cost per mattress.....	\$2.48	\$4.08	\$5.28
2. Comparable quality, but change in relative prices of waste and linters			
Average quality			
Same grades of linters and waste with different prices			
Percentage of linters.....	50%	60%	70%
Weight of linters.....	20 lbs.	24 lbs.	28 lbs.
Price of linters.....	9-1/2¢	9¢	8-1/2¢
Cost of linters per unit.....	\$1.90	\$2.16	\$2.38
Percentage of waste fiber.....	50%	40%	30%
Weight of waste fiber.....	20 lbs.	16 lbs.	12 lbs.
Price of waste fiber.....	9-1/4¢	10¢	11-1/2¢
Cost of waste per unit.....	\$1.85	\$1.60	\$1.38
Total.....	\$3.75	\$3.76	\$3.76

Competitive materials. --Another factor affecting the use of linters in bedding is the use of competitive materials instead of cotton felt. Competitive materials include foam rubber, rubberized hair, and wood fiber batting. Foam rubber and rubberized hair are more expensive than cotton felt, but give much the same effect in bedding as cotton felt. Wood fiber batting is competitive with cotton felt in price, but does not have the resiliency of cotton felt.

Foam rubber and rubberized hair are used primarily in mattresses, couches, and daybeds. They are seldom, if ever, used in boxsprings. They may be used alone or in combination with cotton felt. When used with cotton felt, they are alternated in layers, and any of the materials may be used as the outer layer, depending upon the effect desired by the manufacturer. Foam rubber has a resiliency of 99 percent compared with 35-45 percent for cotton linters, but the compressibility or firmness of linters is preferable. Foam rubber is used more extensively than rubberized hair.

The cotton felt mattress was still dominant in the market in 1958, accounting for an estimated 90 percent of shipments.

Even though foam rubber mattresses have increased the consumer range of choice, the fiber-filled mattress remains the major type produced. Trends in 1958 indicated that, unless there are significant improvements in foam rubber characteristics and more competitive pricing, foam rubber products will not rise greatly above 10 percent of the total market.

Wood fiber batting is seldom used alone except in box springs. When used in other bedding, it is used in combination with cotton felt, and the cotton felt is used as the outer layer. Wood fiber batting is not as resilient as cotton felt; therefore, it produces a harder surface.

The partial success of latex products in mattresses, seat cushions, and padding has spurred research and development of other materials for similar uses. Research on foam vinyl plastic and polyurethanes indicates interesting possibilities for these foam plastics in direct competition with latex or fiber products, depending on the end use. Research progress indicates that these materials will not be a major factor in the market until the early 1960's. Sales estimates for 1957 showed that 6 million pounds of foam materials other than rubber were used. It is estimated that 12 to 15 million pounds of vinyl and polyurethane were produced in 1958. On balance, the most serious immediate competitive disadvantage of cotton felts as a bedding material is the lack of constructive development work on improvement of cotton linters as a raw material.

Automobile Felt

Automobile cushions are the second most important market outlet for cotton felt made from linters and cotton waste. Automobile felt has become rather well standardized, and the mixes for a specific make of automobile have changed very little in the last several years. Generally, two qualities of felt are used in each automobile, and these felts are usually designated as white pads and colored pads. The white pad is the higher quality of the two, contains a higher percentage of linters, and is more resilient. The colored pad gets its name from dyed cotton waste used in the mix.

The composition of the white cotton felt is much the same throughout the automobile industry. The mix is usually made of 60 percent high-quality first-cut linters and 40 percent high-quality cotton waste. The composition of the colored cotton felt ranges from a low of 20 percent to a high of 60 percent linters. The quality of the linters used in the colored felt is not so good as that used for the white felt. Low-grade first-cut, mill-run, and second-cut linters are used in the colored felts.

The composition of the felts is specified to the felting producer by the automobile manufacturer, with allowable substitutions as long as quality is maintained. The composition of the mixes is not likely to be changed by the automobile manufacturer as long as

the price relationship of the raw materials does not change significantly. This is not likely to happen, because prices of felting linters and cotton waste tend to move together.

Staple, color, and resiliency are the quality characteristics most desired of linters going into felts for automobile seat and back cushions. There are differences of opinion as to which is the most important characteristic. About 50 percent of the firms producing automobile felt considered staple the most important and the other 50 percent considered resiliency most important. About three-fourths of the firms considered color as the next most important characteristic.

The difference in utility characteristics is important in comparing the factors leading to the use of cotton felts or foam rubber. Foam rubber is seldom used alone, but is used in combination with cotton felt, hair, sisal, or jute. Foam rubber may be used as a top pad over cotton felt or as a core with a top pad of cotton felt. Cushions containing foam rubber are considerably more costly, and it is conceivable that this market for linters could be regained and possibly expanded if adequately promoted and developed on the basis of quality and the cost advantage of linters. Jute or sisal may be substituted for cotton felt or foam rubber when not used as the top pad.

Even with the various combinations of materials that may be used in automobile cushions, cotton felt is still the major padding material. When other materials are substituted for cotton felt, they are usually substituted in the seat cushions and less often in the back cushions.

When both colored and white pads are used in automobile cushions, the colored pad is closest to the springs and the white pad is the top pad. One method of assembling a cushion from the spring out is to place burlap, sisal, or a flexolator over the springs, on top of which is placed the colored pad, then the white pad, over which is placed tobacco cloth and then the outer cushion covering. Production of the cotton felt pads and assembly of the cushions requires a great deal of hand labor, and some members of the trade feel that if there is complete substitution of foam rubber or other foam materials for cotton felt, it will be for the purpose of putting the assembly of the cushions on an assembly-line basis.²

A comparison of the characteristics of competing materials and cotton felt indicates that cotton felt is better suited for use in automobile cushions than the competitive materials. Foam rubber, sisal pads, rubberized hair, and jute are more limited in use in automobiles than is cotton felt. It is in cushions, particularly in the front seat, that foam rubber has been substituted for cotton felt. The back seats and the backs of seats are still principally made from cotton felt.

Commercial Felters

Commercial felters are those firms whose primary function is the production of cotton felt for sale to other firms for the manufacture of upholstered furniture, bedding, playpen pads, baby-buggy pads, quilts, and miscellaneous items, and for the renovation of upholstered furniture and bedding. The sale of cotton felt for making quilts and other padded items in the home used to be an important, but relatively small, market outlet. However, this market is declining because not so many quilts and comforters are being made in the home as in the past. Instead, consumers are buying synthetic fiber quilts and comforters. Extensive advertising by the producers of synthetic fibers has helped to give the advantage to synthetics over natural fibers.

Commercial felters make several grades of cotton felt. Each firm establishes its own grades. A large part of the volume produced by most firms is in a few grades of cotton felts for general consumption, such as the volume production for furniture and bedding. In addition, several firms produce special grades for individual accounts. Some specialty grades may be produced only once.

² The saving in hand labor in end-product fabrication with urethane foams in cushions may run as high as one-third of the present costs in using cotton felts.

Due to the large number of grades (or mixes) and the difference in kind and quality of waste that may be used, there is no common denominator for determining the range in the amount of linters used per mix or the weighted average amount. The commercial cotton felts range from those with no linters to 100 percent linters. However, it is believed that most of the linters used would be in felts containing 25 percent to 50 percent linters. The rest of the mixes consist of various kinds and qualities of cotton waste. Generally, the kind and quality of the cotton waste determines the quality of felt produced.

Many felt users do not know the composition of the felt they purchase. They buy on sample. For most purposes, they want the felt to be clean and resilient and, above all, to hold together. Color is important for appearance only, and it may or may not be important to the user.

The felt market fluctuates a great deal. A user wants high-grade felt at one time, and the next time a lower grade felt for the same use. Harshness or resiliency in commercial felt is not much of a selling point. However, Texas linters are preferred by some commercial felters for their resilient character, even though resiliency in felt is not a requirement of the purchaser.

About two-thirds of the commercial felting firms furnishing information stated that price governed the percentage of linters used in each mix, and 75 percent stated that a change in price relationship would cause a change in percentage of linters used, particularly in medium- and low-priced felts. Although price was given as the deciding factor in most cases, it was conditioned on the quality of linters available and the quality of felt to be produced.

Furniture Stuffing and Padding. -- Use of linters in upholstered furniture declined from over 150,000 bales in 1948 to less than 95,000 bales in 1955.

The popularity of foam rubber seat cushions continues to expand. Advertising and promotion have been important factors in expanding foam rubber sales. The appearance of an upholstered furniture cushion after use is important, and a resilient cushion has advantages over the expensive, fluffy down cushion which must be reshaped for neat appearance after use. The permanent set and softness of foam rubber are desirable from the standpoint of appearance; however, a poor upholstery fabric tends to wrinkle over foam rubber. Resiliency is needed to keep the loft in cotton felt, but longer staples are needed for retention of shape. All felt furniture has the advantage of price for comparable quality groups, but foam rubber furniture at present continues to have the sales appeal, perhaps largely because of strong promotional efforts.

Cotton felt for use in furniture will likely continue to meet keen competition from foam rubber as well as from other new materials that may be introduced. Foam vinyl and polyurethane plastics for padding or cushioning appear promising for use in furniture. Sales of both vinyl and urethane plastics were only about 6 million pounds in 1955. Sales in 1957 were over 10 million pounds and estimates place 1958 sales at over 45 million pounds. New processing techniques indicates lower prices and improved characteristics. With present consumption of foam rubber in furniture fluctuating around 65 million pounds annually, it is not likely that foam vinyl and urethane plastics could capture a large share of this market from cotton felts and foam rubber by 1960.

Other Uses of Linters as a Fiber

Other uses of linters as a fiber include those in wadding, felt-base floor covering, battery boxes, absorbent cotton, filter fabrics, blankets and yarn, insulation, and stuffing for cot pads and glider cushions. These are all low-volume uses, but the quality of the linters desired for them ranges from low-quality second cuts to high-grade firstcuts.

Wadding. -- This use is closely related to the use of linters in mattress felts and other end products using wadding, such as dinette chairs, quilts for beds, card tables, and similar items the use of which has expanded in recent years. These products require

less resiliency, bounce, or loft than mattresses and cushions. Desired character as measured by resiliency of fibers is less important in wadding and quilts, while cleanliness and staple in relation to price are relatively more important. However, the use of linters and cotton waste in such products is meeting increased competition from waste synthetic fibers and low-priced wood cellulose wadding.

The important factors affecting the use of a linters-cotton waste mix in these outlets are (1) relative prices and fiber cost in the finished product, and (2) cleanliness.

The first factor may be demonstrated by the following comparison of costs of a cotton linter-cotton waste wadding with a competitive material from waste synthetic fibers:

	Cotton wadding	Waste synthetic
Weight per unit	6 ounces	3-1/2 ounces
Purchased weight of fiber	6-1/2 ounces	3-1/2 ounces
Price per pound of fiber	13-15 cents	27 cents
Fiber cost per unit	5.3-6.1 cents	5.9 cents

The illustration points up the sharp competition between cotton fiber wadding and waste synthetic fiber wadding in these uses.

New manufacturing techniques have been developed to fabricate products from new materials to compete with cotton felts. The dirt and foreign-matter content of linters is a prime drawback in making wadding when the fabrics are to be laminated.

Wood cellulose wadding competes with cotton wadding principally on a price basis. Wood batting does not have the resiliency of cotton felt, but it is cheaper, and market outlets have been expanding.

Smooth Surface Floor Covering. --Felt-backed floor coverings combine some of the characteristics of soft and hard floor coverings. Price has been and will be a primary competitive attribute favoring this type of floor covering in competition with other materials. Various grades of felt-backed floor coverings--which account for a large part of the total output--are produced from the lower priced raw materials. Smooth-surface floor coverings that may be felt backed include enamel and vinyl dry-lay coverings, and linoleum and vinyl coverings in the group applied with adhesives.

Emphasis on end-product price restricts the choice of materials used in felt-backed floor coverings to the lowest priced fiber available which will produce floor coverings having adequate strength, dimensional stability, flexibility, and elasticity.

For many years, cotton waste has been used in making the web or felt for felt-backed floor coverings. Linters have been used in the felt mix, but price has frequently been an important barrier. Reprocessed fiber of adequate quality may be purchased at one-fourth to one-half the price of linters.

Gradual increases in the cost of installing wood floors have also had adverse effects on the cost of installing felt-backed floor coverings. Consumers now may choose from a wide variety of hard floor coverings which include vinyl and asphalt tiles and other rubber and composition products.

The competitive price situation of fibers in the construction of felt-backed floor coverings in 1955-58 resulted in reduced use of linters in these products.

Battery boxes. --In making a composition battery box, fiber is used as a binder and to add strength to the box. The binder web must have two primary characteristics, strength and uniformity.

Use of linters alone provides the necessary strength, but other fibers are added to achieve uniformity. In this use, linters are normally used in combination with other low-priced waste fibers.

The main competition of the fiber-reinforced box is a box made of hard rubber. In 1957, the prices of the primary raw materials used in the two kinds of battery boxes became competitive. The margin between costs per pound of the materials used in composition battery boxes and hard-rubber boxes has decreased considerably with the increased production of synthetic rubber. Linters remain much cheaper per pound of raw material, but technological improvements in the molding and drying (heat setting) of rubber have reduced processing time and costs relative to those encountered in producing composition battery boxes. Also, location of the storage battery near the automobile motor has favored the use of the hard-rubber casing in competition with the composition box using linters. In the exposed position the battery box must be more durable.

The cost and supply of other waste fibers used with linters in composition battery boxes have intensified the problem of making a suitable battery box at a price low enough to compete with the hard-rubber casing. The combination of these unfavorable factors apparently will continue to be important in limiting the use of linters in this outlet. It is estimated that between 1955 and 1958, linters consumption in battery boxes declined by more than 50 percent. According to trade sources, current consumption of linters for battery boxes will continue to decline unless both technical and economic conditions change considerably.

Absorbent cotton. -- Absorbent cotton requires a clean, resilient fiber with sufficient staple to reduce "linting" of the product which comes in contact with liquids. Desirable qualities of linters for use as absorbent cotton are resiliency, absorbency, and low price.

Disadvantages of linters for use in absorbent cotton are:

1. The average linter fiber is too short for most end-use requirements of products where absorbency is the primary requirement. Linters must be mixed with more expensive fibers for successful carding.
2. The cost of sufficiently cleaning and bleaching linters for medical uses is high.
3. Changes in design and specifications for products have reduced the number of individual types of products, especially in medical use, in which linters can be used.
4. The volume markets for cotton as a raw material for absorbent products actually require a short staple cotton. Linters or cotton waste are sometimes used as a filler, to reduce costs when the fiber does not have to be spun into yarn.

The trend toward increasing emphasis on product quality and utility, while maintaining the lowest cost possible, does not favor increased use of linters in absorbent cotton. Price is an important advantage of linters in this use only if the requirements of staple are met. Technically, neither imported nor domestic linters adequately meet the requirements of absorbency as effectively as short staple cotton.

Linters used in products of this type are about one-third the price of short staple cotton and about half the price of cotton shoddy from mattresses. However, linters of this quality are higher priced than some types of cotton waste of acceptable quality.

Filter fabrics. -- For fast filtration, filters made from linters are being used. In filtering coarse materials, linters offer the advantage of low cost with sufficient wet strength and efficient filtration. The total volume of linters used in this form is very small.

Blankets and yarn. --Total use of linters for blankets and yarn is estimated to be below 5,000 bales per year. Blanket manufacturers seek to produce cotton blankets with maximum loft retention and at low cost. Linters produced in some areas have sufficient resiliency to impart loft, but the staple is too short to hold together well without the addition of other fibers.

Linters are used in cotton blankets to provide permanent loft to the product, but the volume used for this purpose is small. Imported short, resilient staple cottons provide the primary fiber content for insulation and loft characteristics of cotton blankets.

For very low-priced products such as mops, linters are mixed with other fibers in producing yarns. The longest staple linters are unsatisfactory for efficient yarn production and, as a result, the use of linters in yarns has declined, particularly in the last 2 years.

Insulation. --Linters were formerly used in refrigerator boxes, home attics, and walls as a cheap insulating material. The product was made available in fire-resistant form,

Some technological developments in new materials for insulation that have offered some advantages over linters are:

1. The development of fibers that could be air-blown into attics, walls, or panels. Increasing costs of fabrication and installation of linters insulation strips have decreased the advantage of the initial low fiber price.
2. The development of lighter weight materials offering not only improved thermal insulation but also sound insulation advantages. The accelerated growth in the market for thermal insulation increased the production of competitive materials beyond what could potentially be composed of linters.

Under current competitive conditions, the potential market for thermal insulation using cotton linters is virtually nonexistent. Changing economic and technical factors are tending to favor materials other than linters for insulation, as the greater utility of such materials outweighs the possible price advantages of linters.

Stuffing. --Neither resiliency, staple, nor color is important in linters used as stuffing for low-cost items such as cot pads and glider cushions. Cleanliness is of minor importance. The usual method of making these products is first to make the cover and then to blow the linters in through an opening which is then sewed up. The linters may be sprayed with a light oil during the filling operation to keep down dust.

Price is the overriding factor governing the use or non-use of linters in these products. When the cost of linters gets too high, the articles come into competition with higher priced items of superior quality made from other materials.

Chemical Linters

In the late 1950's, some 60 percent of all domestic linters have been used as a source of cellulose pulp for the chemical industry. The annual fluctuations in supply and price have had a greater adverse effect on the market potentials for chemical linters than for felting linters.

Cellulose pulp is an intermediate product processed from cotton linters or woodpulp for use in the manufacture of rayon, acetate, cellulose plastics, rag-content paper, lacquers, photographic film, explosives, and other products. About 95 percent of the linters going into these uses are converted to cellulose pulp for the chemical industry by a few firms referred to as bleachers.

By far the largest outlets for cellulose pulp from 1948 to 1955 were wearing apparel and tire cord made from viscose rayon and acetate. Cuprammonium rayon is used in making sheer rayon fabrics characterized by fine denier yarns having good uniformity and flexibility. However, it costs more to make cuprammonium rayon than viscose or acetate, and production is declining.

Because of the greater price and supply stability of woodpulp, it is used for viscose rayon and acetate products when possible. Linters pulp has a higher yield, but woodpulp filters better and its processing costs are less. Linters pulp is preferred when quality is of prime importance, because it is higher in purity, clarity, tenacity, and fatigue resistance. The high-tenacity and fatigue qualities of viscose rayon from linters pulp formerly were definitely desirable for high-tenacity tire cord and for strength in delicate fabrics.

Now there is only a slight advantage to using linters pulp in high-tenacity viscose rayon when the price of woodpulp is fully competitive. The competitive strength of woodpulp results from improved technology in purification and sustained improvement in quality and upgrading of the product.

Linters pulp is the source of a large percentage of the cellulose used in clear acetate plastics, films, and lacquers. These products require a high degree of purity, uniform polymerization, and high reactivity in the raw material, as a basis for excellent color, haze, and stability characteristics.

An expanding use of cotton linters is in the production of fine writing paper and specialty paper. Use of linters for making paper has developed primarily because it is becoming more and more difficult to get sufficient quantities of pure cotton rags because of the growing practice of blending natural and synthetic fibers.

In the production of cellulose acetate fibers, a higher yield is obtained from linters pulp, pound for pound, than from woodpulp. The difference is not large, but it is significant. Linters pulp is less moisture-sensitive and can be handled in a dryer state than can woodpulp. On the deficit side, linters pulp experiences more seasonal and quality fluctuations than does woodpulp. Sheet linters pulp is not suitable for the production of acetate fibers, because the Jordaning process (a pulp refining process), used at the bleachers for making sheet pulp changes the physical makeup of the fibers, which causes unsatisfactory results in acetylation compared with bulk linters pulp. In bulk form, linters pulp is more bulky than woodpulp, which results in higher shipping costs for linters pulp.

In plastics, from a quality standpoint, linters pulp has a definite advantage for making clears, crystals, and tints. Most advantages for linters pulp can be met by better cleaning and refining of woodpulp, but that process would increase the cost of woodpulp. The dissolving woodpulp industry has been trying to develop a tailor-made plastic pulp. The acetate fiber grades are used for plastic production. Many items are made from cellulose acetate plastic materials; they include automobile push buttons, knobs, and steering wheels, mechanical pens and pencils, beads, lamp shades, sequins, colored telephones, shoe heels, and film for packaging and other uses. Of these, the colored telephones probably account for the largest outlet for linters pulp, because it has toughness and ability to take uniform coloring which are more important than cost for colored telephones. Linters pulp is also preferred for toughness and low-haze qualities in clear plastic items such as women's shoe heels, beads, and sequins.

Linters pulp is a good raw material for acetate plastic film, but there is considerable latitude in shifting from one source of cellulose to the other. Radioactivity can contaminate cellulose pulp used for photographic film and other products sensitive to radiation. Therefore, the amount of radiation in the atmosphere is constantly checked while cellulose is processed for these uses. Raw linters and linters pulp may be exposed to radiation at several times from the opening of the cotton boll in the field until completion of the purification process by the bleachers, while woodpulp is less likely to be contaminated at any time except during the purification process. For these reasons, producers

of photographic film and the other products sensitive to radiation will probably turn more and more to woodpulp as the source of cellulose, even though linters pulp is more desirable for other quality and processing reasons.

Price is less important than quality in cuprammonium rayon, because the raw-material cost is a lower percentage of total costs than for viscose rayon or acetate.

Trends in Chemical Uses

Domestic consumption of linters as a source of cellulose averaged over 850,000 bales annually from 1948 to 1956, but declined to 550,000 bales in 1957-58 (table 3.).

The decline in linters consumption by bleachers in 1957-58 dramatically illustrates the importance of price in the competition between linters and dissolving woodpulp as a source of chemical cellulose. The annual rate of bleacher consumption of linters in late 1957 and early 1958 was 40 percent below the 1955-56 season. This sharp decline emphasizes the market vulnerability of linters to dissolving woodpulp. It is estimated that less than 300 thousand bales of chemical linters, or less than one-fourth of annual domestic production, are used in products in which linters, because of inherent quality characteristics, are fairly safe from the competition of dissolving woodpulp. This indicates that about three-fourths of this market for linters, which turns on competitive pricing between cotton pulp and dissolving woodpulp, can be lost overnight without a change in technology.

Consumption and Price

Figure 1 illustrates the stability of dissolving woodpulp prices at a time when there was an increase in consumption of approximately 20 percent by the United States rayon and acetate industry. This increase was from an average of 413,000 tons in 1948-50 to an average of 524,000 tons in 1955-57. The average price of regular-tenacity viscose grade of dissolving woodpulp increased from \$149 per ton in January 1948 to \$164 in July 1948, dropped back to \$150 in October 1949, then rose to \$185 in January 1951, where it remained through 1957. Prices for high-tenacity viscose grade and acetate and cuprammonium grade followed almost the same pattern, and the prices were constant at \$195 and \$225 per ton, respectively, from 1951 through 1957.

During the same period (1948-1957), prices of linters pulp fluctuated considerably. The lowest average annual price was \$172 per ton in 1949 and the highest \$479.20 in 1951 (fig. 2). The chart also shows that consumption of linters pulp by the rayon and acetate industry declined from 134,400 tons in 1950 to 49,000 tons in 1957. The jump in prices and decline in consumption were due in part to the Korean conflict, which caused an increase in demand for linters pulp for use in nitrocellulose products.

Quality Factors

Foreign Material. -- The quality of chemical linters is affected largely by the kind and amount of foreign material mixed with the fibers in the bale. This foreign material also affects the quality of linters cellulose pulp that can be produced from the bale and the end-use products that can be manufactured from it. Linters pulp has to be purified to a higher degree for some end uses than for others.

The variations in cleaning equipment at cottonseed oil mills, plus oil mill processing practices, which in some cases actually lower the quality of linters, have forced bleachers to add sufficient cleaning equipment to remove all types of foreign material. However, it is practically impossible to remove all contamination from linters. Therefore, the bales of linters are again inspected at the bleachers and separated into quality groupings so each bale can be used in production of the type of cellulose pulp for which it is best suited.

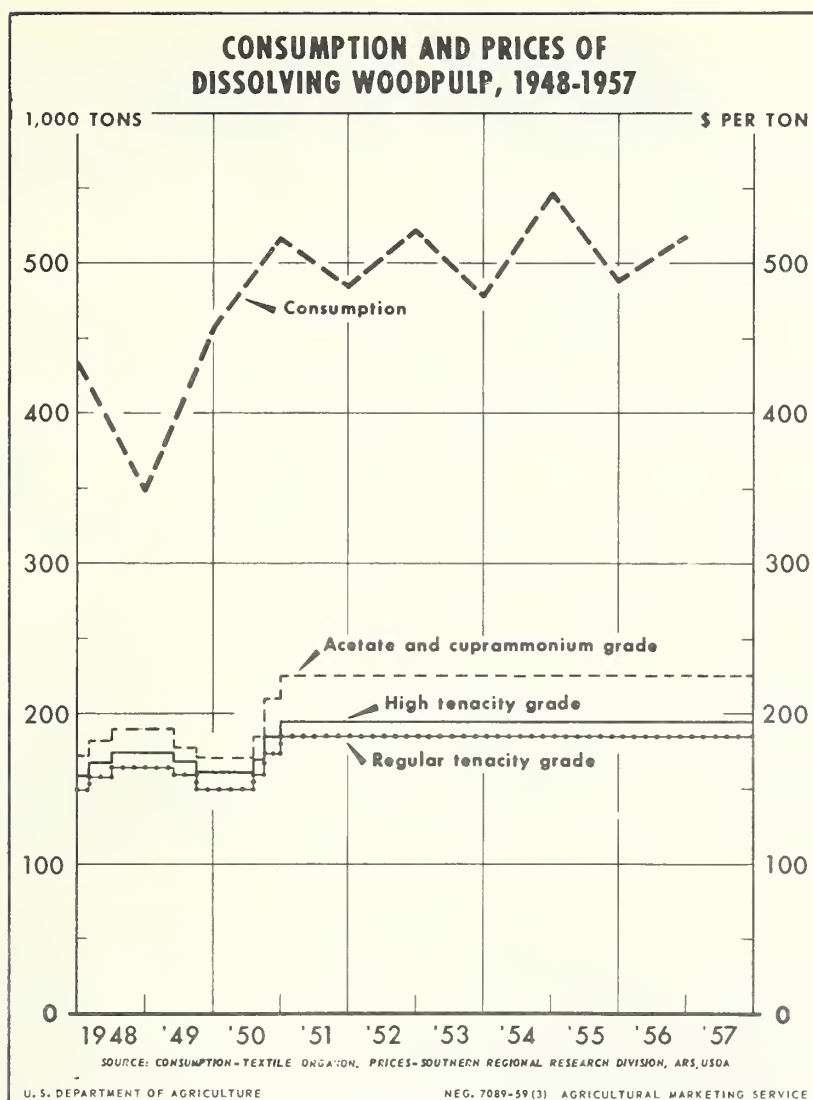


Figure 1.

Impurities such as dirt, field trash, and hull particles are removed from linters by washing them several times, after which they are further purified by chemical and steam cooking in digesters, and then washed again. Following the final washing, the linters are bleached until they are pure white, after which the cellulose pulp is dried and compressed into bales or made into sheet pulp much like blotting paper. The bleaching process is important in the production of high-quality cellulose. Some users of cellulose pulp have equipment to handle the bulk baled pulp; others, the sheet pulp.

The bleachers must maintain strict quality control because they are selling an agricultural product for chemical uses. Linters pulp is purified to end-user specifications. This is essential to maintain markets.

Cellulose Content of Purified Pulp. --Cellulose is a chemical form, rather than a particular chemical compound, and is classified as alpha cellulose, beta cellulose, and gamma cellulose. The alpha cellulose is the usable cellulose in purified pulp. Linters can be purified to produce alpha cellulose content as high as 99.7 percent. Dissolving woodpulp can be refined to produce alpha cellulose content up to about 97.5 percent, but that is a costly operation. Normally, the alpha cellulose content of purified dissolving woodpulp is from 90 to 96.5 percent.

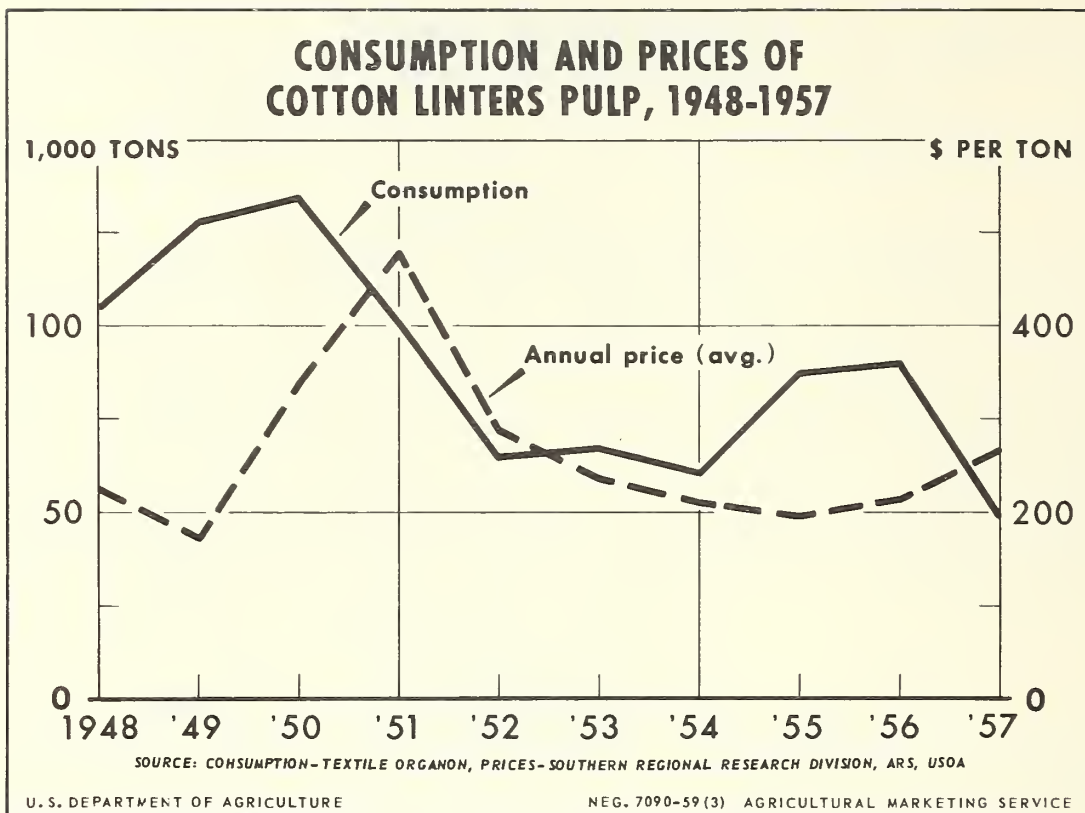


Figure 2.

Rayon and Acetate

Use of rayon and acetate declined in the 1950's, and there were somewhat smaller losses in plastics. Linters pulp held its own as a source of purified pulp in the production of rayon until late in 1956, and accounted for about 19 percent of total domestic consumption of linters for the 1948-55 period, mainly because of the quality superiority of linters pulp in the production of high-tenacity rayon filament yarn. Recent improvements in the purification of woodpulp having high alpha cellulose content have reduced the relative advantage of linters pulp in high-tenacity rayon. In the future, linters pulp must compete more directly with dissolving woodpulp in the production of high-tenacity rayon on the basis of relative prices if this market is to be held. For a number of years, linters pulp has not met the price competition of dissolving woodpulp in the production of ordinary viscose rayon, and, as a result, this market has been lost. The cuprammonium-rayon market was being lost in 1956 and 1957 because linters pulp prices were not competitive. Linters pulp has lost heavily in the production of acetate fibers, declining from a level of 12 to 14 percent of total linters consumption 8 to 10 years ago to less than 5 percent in the late 1950's. Part of this loss was the result of the decline in acetate production. The other part was the result of improved technology in producing a satisfactory dissolving woodpulp, which broadened the range of its substitutability without sacrifice of quality.

Nitrocellulose Products

Production of nitrocellulose for explosives, photographic film, plastics, and lacquers has declined substantially since the estimated record annual consumption of 230,000 bales during the 1952-53 crop year.⁴ Consumption in 1956-57 was under 110,000 bales, and it was expected to be even lower during the 1957-58 season. Except in explosives and lacquers, cellulose acetate has been used to a large extent in place of nitrocellulose.

⁴ Estimates on total use of cellulose nitrate and cellulose acetate based on Cotton Linters, National Cotton Council, 1956.

Cellulose Plastics

Of a total production of 4 billion pounds of plastic materials in 1957, cellulose plastics represented 148 million pounds.⁵ Cellulose plastic production has grown steadily in recent years, although not as spectacularly as the total plastics market. Cellulose plastics output continues to grow despite relative price disadvantages, because of special characteristics for particular applications--cellophane is an exception. Price also is important, relative to prices of other films.

Cellulose acetate consumption, which was reduced sharply in industry during the Korean conflict because of the priority need for cellulose for explosives, increased to the equivalent of over 125,000 bales of cotton linters in 1955 (table 10).

Cellulose nitrate, the original volume plastic material, continues to be used for its toughness and ease of fabrication, but its flammability restricts its use. Nitrocellulose lacquers are highly regarded in many applications, but the total market requires a relatively small volume of linters cellulose.

Until the development, in recent years, of satisfactory gun cotton from woodpulp, the market for cellulose nitrate varied in the past with the need for explosives. The use of cellulose nitrate from linters has declined to less than 100,000 bales in 1957 and 1958.

Cellulose acetate is the primary cellulose derivative in volume use for plastics. Versatility in compounding, toughness, and high impact strength are important characteristics in molded products. For films, clarity, toughness, and built-in flame resistance are the principal quality factors.

Other esters, such as cellulose acetate-butyrate and cellulose propionate, are used in special applications. However, the price of these materials per pound or per cubic inch in molded plastics is higher than prices of other materials which are potential substitutes or are actually competing in the market.

The cost favors the use of dissolving woodpulp over linters in processing, as quality is "built in" rather than inherent in the raw material.

Of the cellulose plastics, ethyl cellulose has a wide range of interesting characteristics. This versatile material now totals over 4 million pounds annually.⁶ Preliminary statistics for 1957 indicate greater use of ethyl cellulose than cellulose nitrate in plastic sheets and rods in that year. The promise of future growth in the use of ethyl cellulose is tempered by its additional cost relative to other materials. Price-quality characteristics create a specialized or limited market for cellulose. New materials have not replaced cellulose as such, but have fulfilled more of the new requirements primarily because of the advantage of price in the large-volume markets.

Chemical modification of cellulose for improved characteristics increases costs and makes processing control and handling more complex in many cases. Industrial familiarity with cellulose aids in the use of this material for new applications where price is not important, but a price disadvantage encourages the development of substitute materials in an effort to lower costs.

The basic raw material costs of cellulose are small relative to the per pound cost of film material, but the historical price variations of linters, in which the price of raw linters has changed from 2 cents to 5 cents per pound within a season, would seriously affect a volume market in which hundreds of thousands of pounds might be used annually.

⁵ Preliminary totals adapted from U. S. Tariff Commission Reports. Total includes plasticizers and other additives in cellulosic compounds besides cellulose.

⁶ Tariff Commission preliminary figures for 1957.

As new cellulosic derivatives are being marketed to meet special requirements, other plastic materials also are being improved to perform special tasks. These materials may be higher priced than the cellulose, but significant gains in certain characteristics make new applications possible. New products must be produced, fabricated, and marketed profitably, and at the same time, they must meet prices of competitive materials. Woodpulp and synthetics which compete with cotton cellulose have three distinct advantages over cotton linters as a chemical raw material:

1. Production volume may be controlled to meet market demand more effectively.
2. Industry is seeking a cheaper or better substitute for linters through research to avoid being dependent on a product with a history of variable quality and price.
3. Technological research is geared to using materials in more abundant supply, to using materials to meet new industrial requirements beyond those met by available materials, and to using materials in which price and quality are more easily calculated and controlled in processing.

Cellulose acetate consumption has increased to approximately 125,000 bales, with future growth expected from ethyl cellulose rather than acetate or nitrate esters.

Sausage Casings

Wet strength, nonreactivity, and behavior under heat are important requirements that must be met in producing sausage casings. Sausage casings have been made from dissolving woodpulp, but the superior quality of the products from linters indicates a market not as susceptible as many others to inroads from competitive materials. It is estimated that an average of 55,000 bales of linters were used annually from 1955 to 1958 for sausage casings.

Sausage casings appear to offer a relatively secure market for linters, and it is expected to increase slowly, but this market represents less than 7 percent of the 1957 consumption of chemical linters.

Rag-Content Writing Paper

The use of linters in writing paper may be considered semichemical. This use provides a general picture of how development work on a vertical scale within the linters industry can pay off in expanding market outlets.

The source of cotton fibers for rag-content paper varies with the specifications and qualities of the paper made. Paper mills, therefore, purchase cotton materials in many different forms for producing paper to meet technical and economic conditions.

Linters have been used for a variety of reasons in recent years as a source of fibrous materials in making high-quality writing paper. Among the most important factors which have led to increased use of cotton linters in rag-content paper are the following:

1. The difficulty of obtaining an adequate supply of rag stock which is free of contaminants, such as permanent dyes and synthetic fibers, has increased in recent years as cotton-synthetic fiber blends have increased.
2. Knowledge and experience, including research findings, have enabled paper firms to use a greater percentage of linters in the manufacture of rag-content papers without lowering quality.
3. The proportion of papers with 25 to 50 percent rag content has increased in comparison to the amount with 75 to 100 percent rag content.

A general comparison of cost and technical characteristics of materials used for manufacturing rag-content papers follows:

Rag content of paper	Raw materials used	Relative cost and physical characteristics
<i>Percent</i>		
25	Linters 25% Woodpulp 75%	Linters are generally cheaper than other sources of cotton fiber. Strength of paper is considered adequate when linters are properly processed.
50	Linters 25% Rag stock 25% Woodpulp 50%	Rags are mixed with linters to maintain strength. Where strength is not a factor, 50 percent linters by weight are used to lower costs.
75 and 100	Linters less than 25% of total, rag stock the remainder	Linters used as filler to reduce costs. Strength of paper and cleanliness of linters restrict use. ¹ Strength and finish characteristics relatively more important than costs.

¹ It is possible to use 100 percent linters, but customer requirements restrict linters use in high-rag-content papers.

The relative price of raw materials is an important factor in determining the mixtures used in making high-quality writing paper. Price considerations include not only the price per pound but relative yields of the materials in pulping operations. Relative costs of linters and various types of rag stock are compared in (table 12).

TABLE 12.--Rag-content paper: Estimated raw material costs, linters and selected rag stock¹

Material	Mill purchase price ²	Cost in paper ³	Relative cost
<i>Linters:</i>	<i>Cents</i>	<i>Cents</i>	<i>Index</i>
Unbleached	<i>per pound</i>	<i>per pound</i>	
Second-cut.....	7	9.00	100
Mill-run.....	7	9.00	100
First-cut.....	11	13.40	149
Bleached			
Second-cut.....	13	16.25	180
Mill-run.....	13	16.25	180
First-cut.....	18	22.50	250
Rag stock			
White shirt cuttings.....	15	15.00	167
Underwear.....	17	17.00	189
Blue overalls.....	18	18.90	210
Unbleached muslin.....	26	26.00	277

¹ Representative 1957 prices.

² Cost delivered, including insurance and freight (c.i.f. price).

³ Based on average shrinkage.

The range in prices of various types of linters and rag stock indicates that linters are not much cheaper than most types of rag stock. Some types of linters are cheaper, but an important problem in utilizing some rag stock is that price is not a true measure of quality for producing good paper. Some types of relatively cheap rags cannot be obtained in sufficient volume to meet market needs. Underwear is the principal rag stock now being used in rag-content papers.

Quality characteristics of linters that are important in paper making are cleanliness and strength. Strength in paper depends on the length and fibrillation of the fibers used.

Industry cooperation among oil mills, dealers, and paper mills has helped to increase the supply of linters with the desired cleanliness. Research and development by pulp producers and end users will determine the competitive prospects for linters, insofar as the relation of paper strength to the amount of linters used in paper is concerned.

The potential increase of linters use in rag-content papers is limited because the actual quantity of such paper produced is not expected to increase above the level of the last decade, even though total production of writing paper is expected to increase (table 13). However, the percentage of linters content in rag-content papers has shown a strong increase since 1949 (table 14). Recent industry estimates indicate that, potentially, linters may be substituted up to 60 percent of the total cotton fibrous materials used in rag-content paper, provided technological improvements can be made in the strength factor of linters. This estimate of the potential is considerably higher than industry estimates of 5 or 6 years ago, when it was thought that the upper limit of substitutable linters in high-quality writing paper would be around 40 percent of the cotton fibrous material used.

TABLE 13.--Production of chemical woodpulp writing paper, and rag-content writing paper, 1946-57

Year	Chemical woodpulp writing paper	Index (1946-48= 100)	Rag- content writing paper	Index (1946-48= 100)	Total writing paper	Index (1946-48= 100)
	1,000 tons		1,000 tons		1,000 tons	
1946.....	726	97	176	109	902	99
1947.....	744	100	174	107	918	101
1948.....	769	103	136	84	905	100
1949.....	686	92	120	74	806	89
1950.....	820	110	138	85	958	106
1951.....	932	125	161	99	1,093	120
1952.....	919	123	132	81	1,051	116
1953.....	898	120	131	81	1,029	113
1954.....	886	119	121	75	1,007	111
1955.....	1,011	136	125	77	1,136	125
1956.....	1,102	148	123	76	1,225	135
1957.....	1,060	142	118	73	1,178	130
1958 ¹	1,099	147	113	70	1,212	133

¹ Estimates based on 9-month figures.

Source: Bureau of the Census.

TABLE 14.--Cotton linters: Estimated use in the cotton content of rag-content paper

Calendar Year	Total cotton fiber consumption in rag-content paper ¹	Estimated use	
		Linters ¹	Linters as percentage of rag content ²
	<i>Million pounds</i>	<i>Million pounds</i>	<i>Percent</i>
1949.....	116	18	16
1950.....	133	20	15
1951.....	155	20	13
1952.....	127	26	21
1953.....	127	27	21
1954.....	121	30	25
1955.....	135	46	34
1956.....	136	53	39
1957.....	128	49	38
1958 ³	120	50	42

¹ Estimates based on data published by the Writing Paper Manufacturers Association.

² Calculated.

³ Estimates based on 9-month figures.

The use of a considerable volume of linters in papers and the trend in use does not necessarily mean that linters use will continue to expand indefinitely. Research and development in the use of woodpulp have contributed to a rapid growth in the production of high-quality writing paper with no cotton content. From 1946-48 to 1956-58, sulphite writing paper production increased 40 percent while production of rag-content papers declined more than 25 percent.

Another factor of competition among raw materials for use in writing paper is the equipment currently being used by paper mills. Mills are reluctant to switch temporarily from one raw material to another if the switch requires equipment changes. Another serious deterrent to a greater shift to linters is that the new supply of linters is governed principally by the size of the cotton crop.

The potential market for linters in paper is limited by the technical problem of achieving adequate strength. Under present competitive conditions and technology, the percentage of linters in the rag content of papers is not expected to rise much above the present level of 38 percent of the total raw material used.

The trend in types of rag-content papers has been toward greater production of 25 to 50 percent rag-content paper, rather than higher percentages. Under existing technology, production by types is not expected to change greatly. The potential for increased use of linters will depend on research and development that will increase the strength factor in linters, and on general domestic economic growth. Even if technological advances in improving the strength factor of linters in papermaking are achieved, increased use of linters in the immediate future will not be as rapid as that which occurred in the middle 1950's.

As indicated by trends in tables 13 and 14, use of linters in rag-content papers, principally writing papers, in 1957-58 is estimated at 168,000 bales or about the same as in 1955-56 (table 10). This is slightly under 1956-57, as might be expected during the business recession in early 1958. The estimate is based on a linters content of approximately 40 percent of the rag content of writing paper. Assuming use of as much as 60 percent linters in the cotton content of rag papers and using the 1952-57 production of rag paper, as a base, the present potential is estimated at 250,000 bales annually, against a consumption of 168,000 in 1957-58.

However, present downward trends of production of cotton-content papers, with an increasing percentage of linters used, indicate a potential use by the paper industry in the next few years of 200,000 to 210,000 bales of linters annually.

Paper mills have a choice of purchasing linters in three relatively different forms, (1) raw linters as produced by oil mills, (2) cotton linter pulp from bleachers of a type specifically processed for paper use, delivered usually with a low moisture content, and (3) linters pulp containing approximately 50 percent moisture, ready for the paper mix.

Cooperation among the paper manufacturers, dealers, bleachers, and oil mills has stimulated the use of linters through better coordination in the production and use of particular qualities of linters or linters pulp.

Foreign Trade In Linters

The consistent growth in foreign free-world economic activity from 1948 through 1957 has increased the demand for both felting and chemical-grade linters. The United States, as the world leader in cottonseed processing, has long been the principal supplier of cotton pulp and chemical-grade linters for making rayon, acetate, and other products. However, U. S. exports of raw chemical linters and cotton pulp have not increased as fast as foreign sources of cellulose nor as fast as U. S. exports of dissolving woodpulp. Trends in exports from 1948 to 1957 are shown in table 15.

Imports

Approximately 95 percent of all linters imported into the U. S. in recent years has been felting linters. The three major sources of imported linters are Mexico, Brazil, and the U.S.S.R. In the most recent 5-year period, 1953-57, linters imports rose to an average of 165,000 bales annually, from the 1935-39 average of about 45,000 bales (table 16).

TABLE 15.--Foreign production of rayon and acetate, and U. S. exports of linters and dissolving woodpulp, 1948-1957

Year beginning August 1	Foreign production of rayon and acetate ¹	U. S. exports	
		Linters pulp equivalent ²	Dissolving woodpulp ³
	1,000 tons	1,000 tons	1,000 tons
1948.....	660	92	18
1949.....	852	88	25
1950.....	1,118	37	28
1951.....	1,344	126	31
1952.....	1,203	56	65
1953.....	1,467	114	69
1954.....	1,706	128	153
1955.....	1,874	166	194
1956.....	2,045	152	214
1957.....	2,148	100	240

Source:

¹ The Cotton Situation, CS 177, U.S. Dept. Agr. compiled from table 14.

² Raw linters exports converted to pulp or 73 percent cellulose base, plus exports of refined linters pulp.

³ Bureau of Census.

TABLE 16.--Exports and imports of raw linters and linters pulp, 1948-57

Year beginning August 1	Exports			Imports total ³	Excess of exports over imports
	Raw linters ¹	Linters pulp ²	Total		
	<i>1,000 bales</i>	<i>1,000 bales</i>	<i>1,000 bales</i>	<i>1,000 bales</i>	<i>1,000 bales</i>
1948.....	239	199	438	115	+323
1949.....	232	188	420	200	+220
1950.....	112	68	180	103	+77
1951.....	271	280	551	113	+438
1952.....	133	130	263	339	-76
1953.....	286	247	533	164	+369
1954.....	313	287	600	185	+415
1955.....	488	316	804	204	+600
1956.....	416	302	718	135	+583
1957*.....	231	170	401	137	+264

*Preliminary.

¹ Converted on basis of average gross weight for all cuts.

² Calculated on the basis of 73 percent cellulose and raw linters and converted to 500-pound gross weight bale equivalents.

³ Imports of refined pulp were reported as negligible.

Source: Compiled from records of the Bureau of the Census and the Foreign Agricultural Service Statistical Bulletin No. 179, and Weekly Cotton Linters Review, U. S. Dept. Agr.

A comparison of price and quality characteristics of domestic and imported felting-type linters is shown below:

Quality characteristics		
Characteristic	Domestic	Foreign
Staple in linters	Short (mostly under 1/4 inch) ⁷	Variable, but longer than domestic, and may include some lint cotton fibers
Degree of resiliency	Supply of resilient types limited	Most supplies are of desired character in relation to staple
Cleanliness	Generally preferred for many felting end uses	Relatively more foreign material, especially of larger size, than in most domestic supplies
Price characteristics ⁸		
Required characteristic	Domestic	Foreign
Adequate staple	Relatively high priced (adequate supply not available)	Low priced in relation to domestic linters
Degree of resiliency	Supply problem, not particularly a price problem	Related to source of supply rather than price
Adequate cleanliness ⁹	Relatively cheap	Relatively high priced

⁷ The relative maximum length of linters fibers is very short compared to short staple cotton fibers.

⁸ Product not priced by characteristic but as a group of characteristics. Comparison made on the basis that a single characteristic was desired for the same quality of a single characteristic in foreign or domestic linters.

⁹ The longer staple and cleanliness of linters are preferred for absorbent cotton for medical use.

Imported linters are preferred for their more than adequate staple. Furthermore, the domestic demand for high-quality felting linters is greater than U. S. production. Since the average delivered prices of foreign linters range up to 2 cents a pound higher than prices of comparable domestic grades, it is apparent that the particular characteristic of felting-grade linters will continue to rise because the potential market is expanding. Furthermore, it is not probable that domestic mills will be able to cut a higher percentage of first cuts, because of the difficulty encountered in maintaining the desired quality and staple. The spread between available domestic supplies and market demand will probably result in greater dependence on imports and the development of substitute materials (fig. 3).

Exports

Growth in the export market for cellulose, relative to growth in the domestic market, increases the significance of foreign markets for chemical-grade linters. Almost all recent exports of raw linters have been of chemical grade. In addition to raw linters exports, U. S. exports of chemical linters pulp added substantially to the percentage of chemical-grade linters dependent on foreign market outlets. Recent trends in U. S. production of chemical-grade linters, bleacher consumption, and linters exports (including pulp and raw linters) are presented in figure 4.

In 1955-56 and 1956-57, exports of raw linters plus the raw linters equivalent of purified pulp exports exceeded imports by nearly 600,000 bales (equivalent 500-pound gross-weight bales). Principal export markets for U. S. chemical linters are West Germany, United Kingdom, France, Japan, the Netherlands, and Canada. Raw linters exports over the 4 years 1953-56 averaged approximately 375,000 bales annually. In 1957, both raw linters and purified pulp exports were much lower than the previous year.

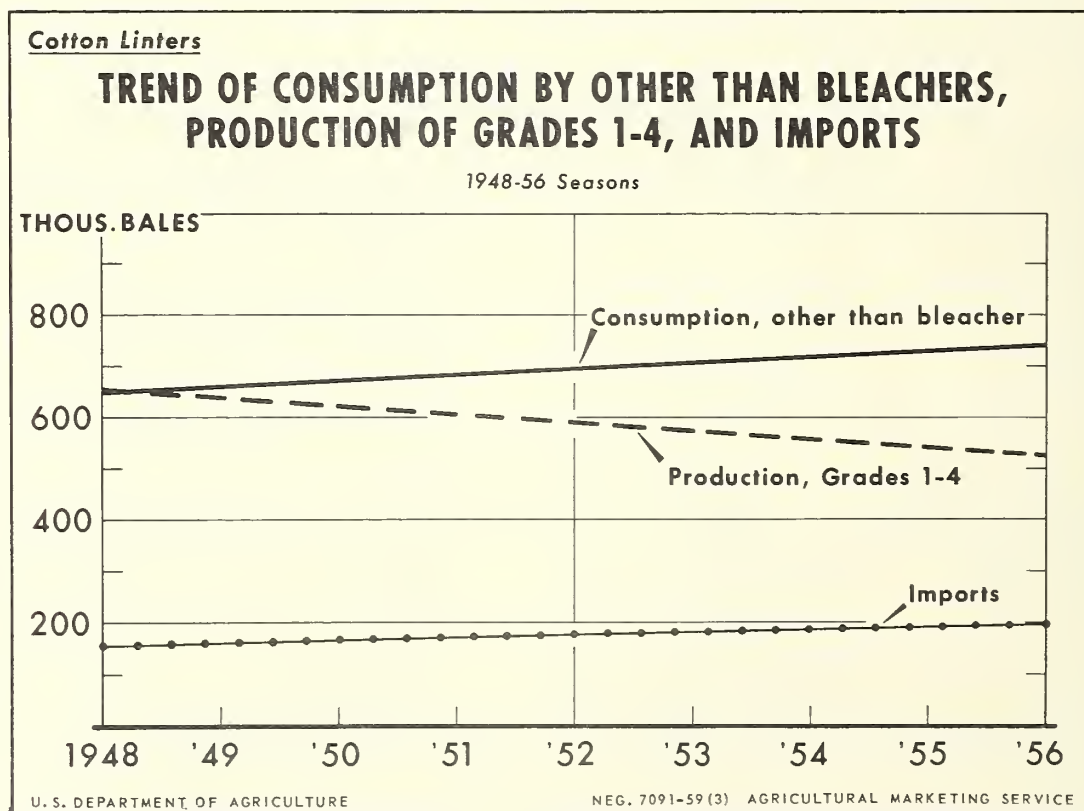
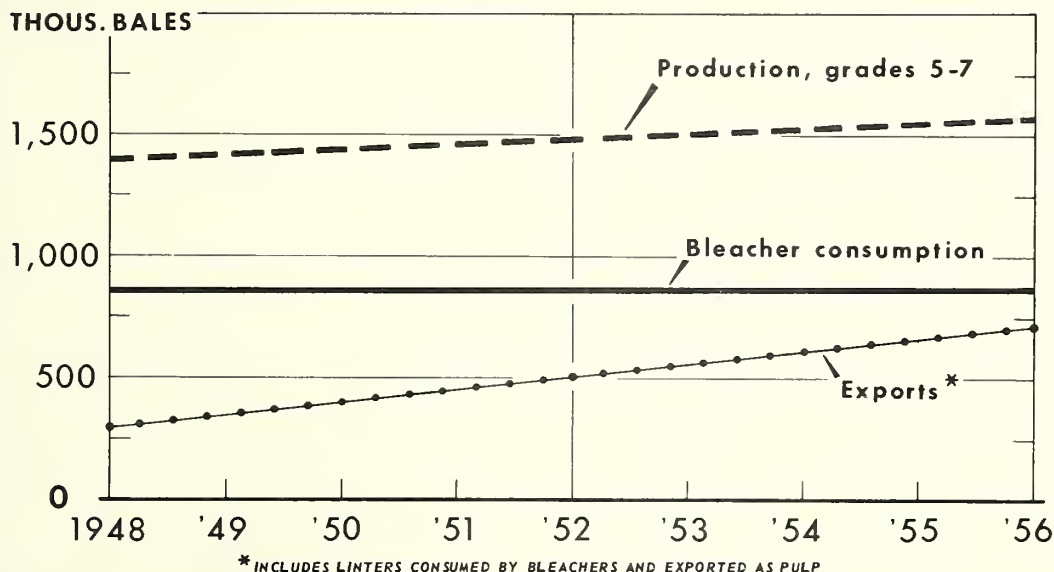


Figure 3

Cotton Linters

TREND OF BLEACHER CONSUMPTION, PRODUCTION OF GRADES 5-7, AND EXPORTS OF LINTERS AND LINTER PULP

1948-56 Seasons



U. S. DEPARTMENT OF AGRICULTURE

NEG. 7092-59 (3) AGRICULTURAL MARKETING SERVICE

Figure 4

Purified linters pulp exports, expressed in terms of equivalent raw linters, have averaged about 291,000 bales annually from 1953 to 1956. Assuming that all raw linters exports are second cuts, it appears that the equivalent of some 666,000 bales of chemical-grade linters were shipped annually to foreign consumers in the 1953-56 period. The significant growth of U. S. exports of dissolving woodpulp, indicates increased foreign competition between these alternative sources of cellulose. This creates uncertainty over the prospects of maintaining a high level of exports of purified linters pulp and increases the importance of price as a competitive factor, since the substitutability of the two materials has been broadened with improved technology in production of dissolving woodpulp.

The increasing domestic production, consumption, and exports of dissolving woodpulp during the 1950's are expected to provide keen competition in all end-use outlets for chemical cellulose. The factors important in the domestic competition between dissolving woodpulp and linters pulp are equally important in the foreign market. However, the prospect for export demand for raw linters for chemical purposes in the early 1960's appears bright on the basis of price relationships in the late 1950's. If cotton-growing countries other than the U. S., Mexico, Brazil, and the U.S.S.R., which are the principal countries that delint their seed, begin to delint higher proportions of their seed, however, the world supply of linters could be increased by one-third, greatly augmenting the supply of chemical as well as felting linters.

Linters imports are made up mainly of felting-type linters originating in Mexico, Russia, and Brazil. Imported felting linters are of good staple and quality, and usually command premium prices in the U. S. market.

TABLE 17.--Cotton linters: Exports and imports by country, annual averages 1935-39, 1946-50, 1951-53, annual 1954-57, 500-pound bales

Country	Exports ¹						
	Annual average			1954-55	1955-56	1956-57	1957-58*
	1935-39	1946-50	1951-53				
	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales
West Germany.....	75	48	63	101	124	140	86
United Kingdom....	79	69	57	67	119	49	41
Netherlands.....	21	--	6	10	36	78	30
Canada.....	13	24	16	23	27	34	29
Japan.....	29	18	38	39	69	69	23
France.....	82	22	44	60	96	28	18
All others.....	26	5	5	13	17	18	4
Total exports...	325	186	229	313	488	416	231

Country	Imports ²						
	Annual average			1954-55	1955-56	1956-57	1957-58*
	1935-39	1946-50	1951-53				
	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales	1,000 bales
Mexico.....	12	53	90	115	136	86	105
U.S.S.R.....	20	40	31	32	47	36	20
Brazil.....	10	27	68	24	13	5	2
All others.....	2	9	18	18	10	13	17
Total.....	44	129	207	189	206	140	144

* Preliminary.

¹ Calculated from official running bale figures.

² Reported net weight, 480-lb. bales.

Foreign purchasers find that the uniformity of U. S. linters and the relative ease with which sufficient quantities of a desired quality of chemical linters or linters pulp can be purchased are important factors in buying linters or pulp. Also, the relatively high and uniform cellulose content of American chemical-grade linters favors continued use by foreign processors.

Evaluation of Market Potential

Trends in the production of linters and in industrial and consumer use of products made from linters will determine future markets for the material. These trends, resulting from economic and technical factors affecting production and utilization during the 1950's, are:

(1) The increased domestic consumption of first-cut or felting-grade linters as related to the decreased production of higher grades of linters normally used in volume in

these markets. Imports of felting linters for these uses have increased over the same period because domestic supplies have been inadequate to meet expanded needs.

(2) Domestic consumption of second-cut linters as a source of cellulose has shown no great increase over the last decade, but exports of raw linters and linters pulp to be used as a source of chemical cellulose abroad have increased.

(3) Materials competitive with linters have gained increased shares of expanding markets in minor as well as in major end uses. Growth in the use of woodpulp in chemical end-use markets, and of foam rubber in felting end uses, are examples of the increased use of competitive materials.

(4) With the exception of dissolving woodpulp, new raw materials for use in products that formerly were made from linters have not been important quantitatively, but the trends are indicative of the nature of future competition.

Except during World Wars I and II, the expanded use of linters has resulted as much from increased production as from anything else. Economic and technical changes have favored the use of linters in some end uses, and research and development in production and use offer possibilities of maintaining constant markets for linters, provided (1) the important physical quality characteristics of linters in major end uses can be maintained at economic costs to producers and industrial users of linters, (2) commercial supplies of linters are not again made scarce by the abnormal needs of war, and (3) research, development, and promotion of linters are maintained at levels adequate to cope with production and utilization problems as industrial requirements continue to change.

Unfavorable economic and technical factors may become more important in adversely affecting the use of linters than they have been in the past. It appears that the main reason why industry has not substituted the newer materials for linters any faster is because the new materials are not as good in quality or as economical to use. It probably will be a long time before there are substitute materials that will displace linters in large volume at competitive prices. Despite the strong staying power of linters in traditional outlets at competitive prices, the use of linters will continue to decrease relatively in comparison to the potential market, because the annual new supply of linters is dependent primarily upon the size of the cotton crop.

Factors Affecting the Market Potential of Linters

Price Fluctuations. -- Wide price fluctuations of chemical and felting-grade linters have created serious problems for principal end users. The wartime demands for nitrocellulose and other military products made from linters, plus the rigidity of production and supply of linters, were responsible for high prices during World War II and the Korean conflict. With improved technology in producing high alpha-cellulose grade dissolving woodpulp, this material has become fully substitutable for linters pulp in the production of more and more end-use products. Since the Korean conflict, the capacity for producing dissolving and special alpha-cellulose grade woodpulp has more than doubled. It is highly unlikely that chemical linters prices will fluctuate as widely as in the past, because it will be necessary for linters pulp to meet dissolving woodpulp prices, which held at constant levels from January 1951 through 1958. To meet the competition of woodpulp at 1958 prices, raw chemical-grade linters would have to sell at no more than 2 1/2 to 3 cents per pound f.o.b., depending upon location and shipping costs from producer to domestic bleacheries. Although there are still some small market outlets in which linters pulp possesses certain quality advantages, they are not of sufficient size, and indications are they will not be in the foreseeable future, to permit chemical linters prices to rise materially above the level set by dissolving woodpulp.

Price movements of felting-grade linters may continue to fluctuate, but even in these uses the fluctuations are not likely to be as great as those during World War II and the Korean conflict, because linters for this purpose not only will have to meet the prices of cotton waste and other fibrous waste materials, but their dominance in felting uses will be restrained by the growing list of substitutable felting materials.

Cleanliness. -- Considerable controversy exists concerning the importance of producing cleaner linters. Practically all groups of end users indicate a desire for improving the cleanliness of raw linters. Only in such highly specialized uses as clear acetate plastics and certain food uses, however, is the desire for cleanliness of such vital importance as to indicate that premium prices would be paid for cleaner linters. The strongest argument for producing cleaner linters or for raising the general level of linters quality, for both chemical and felting grades, is that improved quality would improve the competitive strength of linters, because practically all end users are being forced, through the competitive process, to upgrade their end products.

Cleanliness always has seemed to be relatively more important during periods when the demand for raw linters was sluggish, and less important when the demand was high. The specifications of foreign purchasers usually are somewhat higher than the average quality of second cuts produced. For this reason, producers in areas distant from domestic bleachers attach more importance to producing the cleaner linters, because there is a question whether or not they will find a market for their product. Since it is a practical impossibility to determine premiums, if any, that end users will pay for a higher quality of linters, it is also impossible to demonstrate to producers that it would be to their advantage, in the short run, to spend money to install new or improved cleaning equipment. Because of this situation, commercial machinery manufacturers are hesitant to invest funds to develop and introduce new and improved cottonseed cleaning equipment. As long as it is impossible to demonstrate to the oil mills that purchasers of raw linters are willing to pay a premium for cleaner linters in the short run, it is improbable that there will be any large capital outlays to install more expensive cleaning machinery. This is true despite the fact that the long-run interest of the cottonseed crushing industry lies in the production of cleaner linters, which is basic to the long-term competitive strength of linters as a raw material.

Foreign Trade. -- Foreign trade is a highly significant factor in the domestic linters utilization pattern. In 1955, exports of raw chemical linters, which account for approximately 95 percent of total raw linters exports, and the raw linters equivalents of purified linters exports were in excess of 800,000 bales. Imported linters are confined almost exclusively to high-quality felting grades and in the late 1950's ranged from 100,000 to 200,000 bales annually. The foreign trade pattern thus indicates the imbalance between domestic supply and domestic chemical and felting uses. Prospects for export demand for raw linters or purified linters pulp for chemical uses in the early 1960's appear bright, but the improved technology in producing dissolving woodpulp of high alpha-cellulose grade, which broadens the range of its substitutability for cotton pulp, is expected to have the same competitive impact in foreign markets as in the domestic market. U. S. exports of high-tenacity rayon grades of dissolving woodpulp more than quadrupled between 1952 and 1957. As a result, prices of chemical linters for export also will be geared more closely to dissolving woodpulp prices, which demonstrated remarkable price stability in the late 1950's.

Felting Uses

The long-range outlook for felting linters appears good. Although the market declined sharply in the late 1950's for some of the minor felting uses of linters, and has disappeared almost entirely for others, there are indications that demand for the major uses will increase. Part of the decline in the use of felting linters in the late 1950's may be attributed to the drop in bedding, furniture, and automobile sales. The decline in demand for bedding and furniture was due in part to the decrease in the number of family units formed during that period, which in turn was due to the low birth rate in the depression years of the early 1930's. The number of family units formed per year is expected to rise appreciably in the 1960's when the children of the period of high birth rates following World War II reach maturity and form families. The Bureau of the Census estimates that there will be almost 3 million more persons in the United States in the 20-to-24-year age group in 1965 than in 1955, and over 6 million more in the 14-to-19-year age group.¹⁰

¹⁰ Bureau of the Census, Population Estimates, Series P, No. 123 dated October 20, 1955.

As the demand for bedding materials increases, this market outlet for felting linters probably will expand because of the desirable characteristics of felting materials containing a high percentage of cotton linters. The expansion will occur, however, only if ample supplies of suitable first-cut linters are available and if the cost of these linters, relative to costs of competitive felting materials, does not change greatly from those prevailing in the late 1950's.

Foam rubber, rubberized hair, and wood fiber batting are more competitive with cotton felt for use in furniture than in bedding. Foam rubber is the major competitor, and will likely continue to expand its use in furniture at the expense of cotton felt unless ample supplies of suitable cotton felt are available at a price advantage.

The trend away from cotton felts containing linters and waste in making automobiles is not at all permanent. The factors important to continued use of cotton felts are maintenance of uniformity, improved resiliency, stable supplies, and a competitive price of the raw material.

Attempts to improve resiliency of cotton felts by chemical treatment have not had satisfactory results. Rubberized and plastic-treated cotton have not shown significant improvement in resiliency. Synthetic fiber felts have been too costly, but as the quantity of synthetic fiber wastes expands, the price disadvantage may be reduced. A properly garnetted cotton pad of 60 percent linters and 40 percent cotton waste will continue to be used, provided sufficient volume and quality of raw materials are available at relatively stable prices. Events in the late 1950's indicate that the potential market for linters in automobile felts could be greater than at present. The need for production of linters in sufficient quantity and of the quality needed, at stable and competitive prices, is a major factor limiting the use of linters in automobile felts.

Suitable qualities of vinyl and urethane foams are not likely to be available for bedding and for automobile and furniture padding for several years in quantities sufficient to reduce appreciably the amount of cotton felt used in these products. Industrial development problems often are difficult to overcome. Estimates of various industry sources indicate anticipated sales of 40 to 80 million pounds each of vinyls and urethanes in 1960.

Because of the continued rapid growth in population of the United States since World War II and the rigidity of linters production, it is likely that supplies of suitable first-cut linters will be insufficient to satisfy the demand for cotton felts for bedding, automobile cushions, and furniture. Part of this anticipated increase in demand may be supplied by an increase in the use of foam rubber and other competing padding materials and use of vinyl and urethane foams.

Selected Chemical Uses

Linters pulp has an advantage over woodpulp in its ability to produce higher quality products in some uses. But when the price of linters goes too high, the quality of end products may be sacrificed for price considerations. Supplies of linters pulp are more seasonal in nature, with periodic quality fluctuations.

The high-volume market outlets for linters pulp are in manufacture of viscose rayon and acetate. The other market outlets, though small by comparison, are nevertheless important. Some of the smaller market outlets are the most stable.

Viscose Rayon. -- This market outlet for linters pulp is considered to be the most vulnerable, although it is still one of the major volume outlets. The regular-tenacity viscose market is probably lost to linters permanently because there is little if any quality advantage over woodpulp. Linters pulp has a slight quality advantage for high-tenacity viscose used in tire cord because of its higher alpha cellulose content, but this quality advantage is disappearing. The filtration rate of woodpulp is higher than that of linters, and it costs more per ton to put linters pulp through the viscose process. But the higher alpha cellulose content of about 1 percent offsets the higher cost to some extent. Even so,

woodpulp displaced a considerable volume of linters pulp in high-tenacity tire cord during 1957 and 1958 because of high prices of linters pulp.

Cellulose Acetate. --The cellulose acetate market for linters pulp is the most stable of the volume markets, even though woodpulp provides the larger percent of the cellulose going to this market. The two major product outlets for cellulose acetate pulp are acetate fibers and plastics. Until the late 1950's, more linters pulp was used for acetate fibers than for all other acetate uses combined. In 1957 and 1958, less and less linters pulp was used for acetate fibers, and woodpulp captured almost all of this market. Even so, there is a belief in the industry that if linters pulp prices again become competitive with dissolving woodpulp prices, the volume of linters pulp utilized will increase. Broadly speaking, acetate fibers or yarns can be made equally as well from woodpulp as from linters pulp. Cost and availability of the particular pulp are the controlling factors.

The market for cellulosic plastics increased from 120.6 million pounds in 1954 to approximately 148.1 million pounds in 1957, with cellulose acetate accounting for all but about 9 million pounds of the total in both years.¹¹ It is estimated that linters pulp is used in the production of half of the cellulose acetate plastics. It is believed that the acetate plastics market will expand slowly, and that linters pulp will maintain its relative position as a source of cellulose.

Cellulose Nitrate. --One of the more important market outlets for linters pulp has been in cellulose nitrate for the production of explosives, plastics, lacquers and enamels, fabric coatings, and moisture-proofing cellophane. Demand declined during the late 1950's, and at the same time there was greater substitution of woodpulp. The greatest part of this market for linters pulp is for making lacquers.

Cuprammonium Rayon. --Formerly, cuprammonium rayon was an important market outlet for linters pulp. Now with higher alpha-cellulose grades of woodpulp, the market is no longer dependent upon linters for its raw material.

Cellulose Ethers. --A small but stable and important market is in making cellulose ethers. Some uses of the ethers are in thickening agents, emulsifying agents, grease-proof coatings, paper coatings, and adhesives. This outlet is not dependent upon linters as a source of cellulose, but linters pulp is usually preferred where the demand is for good color, clarity, low ash content, and uniformity.

Sausage Casings, Filters, and Saturation Papers. --Small but fairly stable market outlets exist in manufacture of sausage casings, filters, and saturation papers.

Writing Paper. --This is the most promising market for a permanent increase in consumption of cotton linters. It is estimated that 154,000 bales of linters were used in making writing paper in 1956 and 168,000 in 1957. This was 34 percent and 38 percent, respectively, of the total cotton fiber content in writing papers in these years. The potential market for linters in writing paper is approximately 250,000 bales annually, if technological improvements in the strength of linters make possible the substitution of linters for approximately 60 percent of the total cotton fiber content in rag-content paper.¹² However, it is likely from an analysis of trend that rag-content paper consumption may decline somewhat, reducing the realizable potential to 200,000 to 210,000 bales.

¹¹ U. S. Tariff Commission reports.

¹² Estimates are based on data published by the Writing Paper Manufacturers Association with adjustments for weight loss of linters during cleaning operations.

PRODUCTION AND MARKETING

Supply and Distribution

Cottonseed production has varied substantially from season to season, but from 1935-39 to the late 1950's the trend generally has been upward (table 7).¹³ The primary factor affecting the annual supply of linters is the production of cotton, which determines the production of cottonseed, but the increase in the weight of linters cut from a ton of cottonseed has been an important factor in the annual supply of linters for two decades. In 1956-57, production of linters was 1.5 million running bales from 5.4 million tons of cottonseed, compared with approximately the same production from 8.4 million tons of cottonseed in 1937. Increased linters production is the result of (1) a higher percentage of cotton varieties yielding around 200 pounds of linters per ton of seed, (2) an increase in the average percentage of cottonseed crushed annually by oil mills, from 80 percent of total production in 1935-39 to 92 percent in 1952-56, and (3) an increase in the average volume of linters cut per ton of seed crushed, from 145 pounds in the 1935-39 period to 184 pounds in the 1952-56 period. These three factors have offset the increased gin efficiency, which tends to reduce the residual linters on seed. Some gins find that when seed contain a smaller amount of linters, the grade of the seed increases proportionately. Some gins put seed through linters machines and cut from 20 to 50 pounds of linters off a ton of seed. The incorporation of the linters factor in seed grading rules has reduced considerably the number of gins that cut linters from seed.

Linters production in the 1952-56 period averaged 2,105,000 (500-pound) bales annually, or 50 percent above the 1935-39 average. Total distribution has increased more than domestic production, inasmuch as imports averaged around 208,000 bales annually for the 5-year period 1952-56, compared with 45,000 bales in 1935-39 (see table 16).

Fluctuations in production, supply, disappearance, and prices have tended to obscure other important factors in the supply and distribution pattern.

Marketing and Distribution

Military uses of linters during World War II and the Korean conflict, though temporary, created serious long-run market problems for linters. In both wartime periods, competing materials not needed for military purposes were thoroughly investigated and frequently substituted for linters in many industrial and consumer products. Relatively high prices for linters provided an additional stimulus for manufacturers to seek substitutes immediately after the suspension of price controls in 1946 and again during 1950 and 1951 (table 5).

Relatively low linters prices associated with the large cotton crops of 1949, 1951, 1952, and 1953 did not result immediately in any appreciable rise in industrial use of linters. Commercial users have regarded linters as a product of great instability and uncertainty in both supply and price.

In 1949, in accordance with price support legislation, the Commodity Credit Corporation purchased large quantities of linters. These linters were liquidated in fiscal 1950, but sales during the fiscal years 1952, 1953, 1954, and 1955 lagged considerably behind acquisitions. Only in fiscal 1951 were CCC sales made at prices exceeding the cost of the linters acquired in price support operations.

Increased domestic industrial usage, together with increased exports, in 1955 and 1956 exceeded the reduced production and imports of linters for the 1954-55 and 1955-56 crop years. CCC sales at market prices in fiscal 1956 were made for \$39 million less than the \$58 million at which they were acquired.¹⁴ Fiscal year-end stocks during this

¹³ The record production of 8,426,000 tons in 1937 has never been approached; however, in 1953, 6,740,000 tons of seed were produced as compared to the 1935-39 average of 5,827,000 tons.

¹⁴ Annual reports of the Commodity Credit Corporation, 1955 and 1956.

period were reduced from over 1.2 million bales to less than 300,000. During fiscal 1957, most of the remaining stocks of linters were sold. Losses on stocks over the 4-year period 1954 to 1957 illustrate the complexity of handling linters, either by Government or by industry.

Market uncertainty resulting from instability in the supply and price of linters since World War II is discouraging to domestic manufacturers, who are interested in expanding the use of linters in traditional outlets, and to those interested in new product potentials.

Geographic Production Shifts and Related Changes in Linters Production

Oil mill purchases in the four major cotton-producing areas indicate some significant trends since 1938.¹⁵ The volume of cottonseed processed in the Far West showed a sizable gain in the 1938-58 period, both in actual tonnage and in percentage of total cottonseed crushed annually (fig. 5).

The Delta region shows an increase in actual tonnage crushed, but a reduction in percentage of total annual cottonseed crushed since 1938-40. The Southwest shows a reduction in percentage of total crushings since 1947-49, but an increase in actual tonnage in 1953-55 over previous periods. The downward trend in tonnage

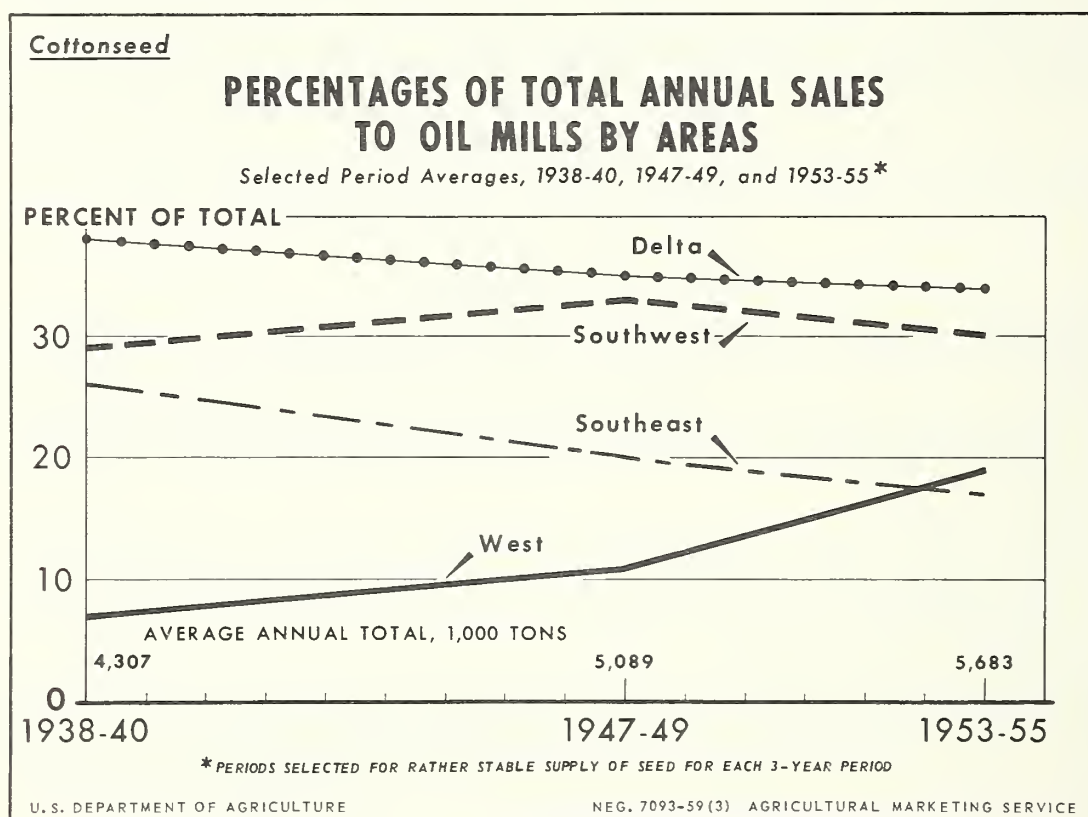


Figure 5

¹⁵ Geographic areas used and States included are as follows:
 Southeast - North Carolina, South Carolina, Georgia, and Alabama.
 Delta - Missouri, Arkansas, Tennessee, Mississippi, and Louisiana
 Southwest - Texas and Oklahoma.
 Far West - New Mexico, Arizona, and California.

crushed in the Southeast is in contrast to the increase in the total national crop crushed and also the increased production in other areas. With the shift of cotton production westward, linters are being produced at a greater distance from established processors and end users. There has been also a shift in the predominant varieties produced, as well as shifts from hand harvesting to mechanical harvesting. These changes have brought about a change in linters quality. Since linters quality is related to changes in production practices and the shifts in production areas, a brief description of what has happened, by production areas, is of value in identifying marketing and utilization problems.

Southeast

Oil mills in the Southeast have experienced a slowly declining average volume of seed available for crushing during the 1940's and 1950's. The seed obtainable comes largely from cotton of the Coker variety, which is usually harvested by hand picking. One ton of Coker seed yields approximately 13 percent, or 260 pounds, of linters, which are medium white in color and of medium soft character as compared to linters from other varieties.¹⁶

Delta

Oil mills in the Delta have experienced a small increase in the quantity of seed available, although supply varies considerably from year to year. About 80 percent of the seed crushed in this area is from the Deltapine variety of cotton. Much of the cotton in the Delta is handpicked and contains about 10 percent, or 200 pounds, of linters per ton of seed crushed. These linters are relatively soft in comparison with linters from other varieties of cottonseed, and may bear a green or brownish (yellow to red) cast.

Southwest

The absolute quantity of cottonseed available for crushing has increased in the Southwest, but annual production varies greatly because of variations in rainfall. Many varieties, including Deltapine, Rowden, Northern Star, Stormproof, and Lankart, are grown in the Southwest. Lankart was the leading variety in 1957, accounting for about one-third of total crushings, while no other variety accounted for as much as 20 percent of total seed crushed. Linters produced in this region have a wide variety of color, resiliency, and staple. It is in this region that the area of production and the processing methods are important in utilization of linters. Production per ton of seed varies by variety. Important varieties in the area produce about 190 pounds of linters per ton of seed. About half of the seed crushed is harvested by hand snapping, 20 percent by machine stripping, and 20 percent by hand picking.

Far West

As cotton production shifted westward, the seed available for crushing has increased. About half the cotton in the Far West is hand picked, and the other half is machine picked. The dominant variety of seed is Acala, which yields 200 to 240 pounds of linters per ton of seed. Linters from this variety are creamy white and relatively resilient in character.

The trends described substantiate the contention by end users that the quality of linters available today is not the same as it was in the past. This is true especially if quality is measured in terms of color, degree of resiliency, and staple as affected by changes in variety, production and ginning practices, and a higher average cut of linters per ton of seed.

Production of linters in the 1950's by grade indicates an increase in the percentage of grades 5 and 6, and a slight decrease in the proportion of grades 2 and 3 when classified according to 1926 standards (fig. 6). New standards adopted July 1, 1956, have not

¹⁶ In all areas, it has been found to be uneconomic to cut all the linters off the seed. Residual varies from 1 1/2 to 2 1/2 percent, or 30 to 50 pounds, depending on a combination of economic and technical factors concerned with oil mill operation.

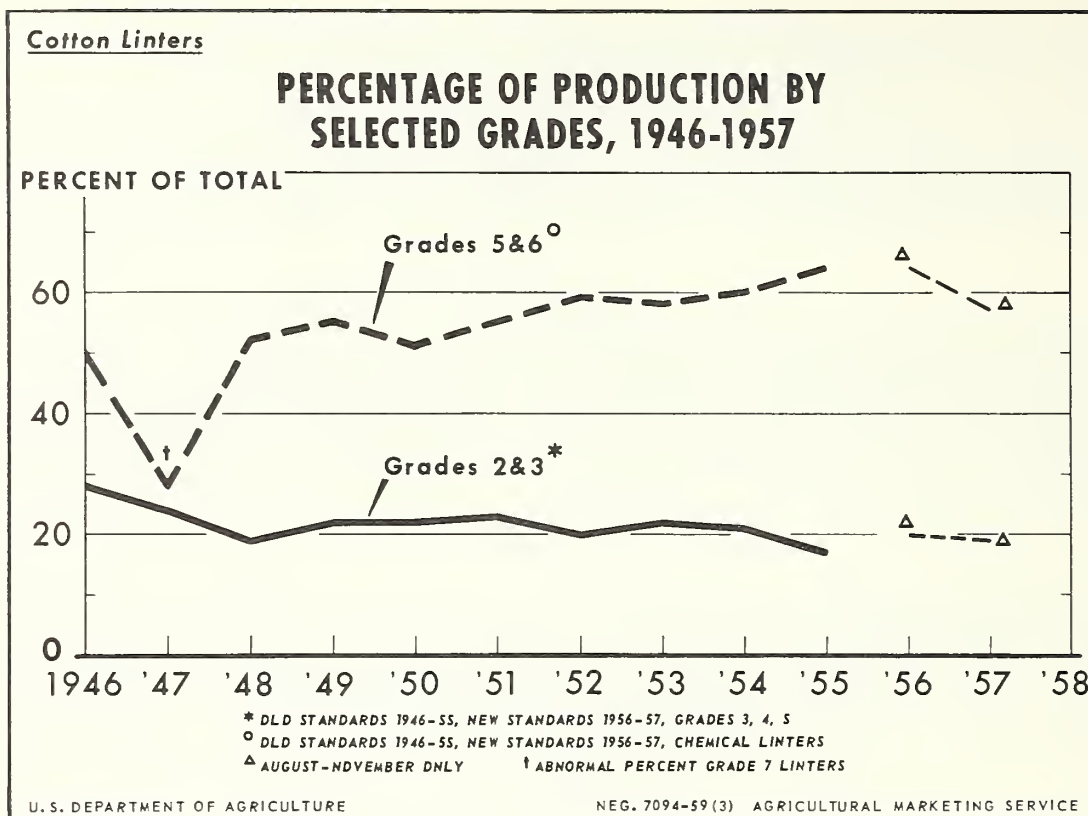


Figure 6

been used long enough to indicate trends, but the percentage of linters below grade 7 produced through the earlier part of the 1957-58 season seems to indicate that the previous trend to lower grades has continued.¹⁷ However, oil mill practices have an important effect on the grades actually produced from cottonseed.

Oil Mill Practices

Government and commercial standards for grading cottonseed have been developed to indicate the value of the joint products contained in a given lot of seed. Cotton linters content of cottonseed is a mandatory factor under official standards, but optional under trade practices. Trade practices probably reflect the knowledge of typical outturn of linters when measuring other properties of cottonseed.

Many oil mills do not purchase seed on the basis of grade, although almost all of them analyze the seed after purchase. Two reasons have been given by oil mill operators for not purchasing seed on the basis of grade:

1. When seed available for crushing in an area is below standard, most mills appear to attach more importance to obtaining enough seed to permit economical oil mill operations than to the intrinsic quality of the seed.
2. A few gin operators will not sell cottonseed on grade but sell on an "as is" basis. These ginners apparently believe they can obtain a higher average price for seed by using this method.

¹⁷New grade not directly comparable to old standards.

Quality Controls in Producing Cotton Linters

Basically, linters are removed from cottonseed in order to achieve greater efficiency in processing oil and meal. There are four stages of quality control that may be considered by oil mills in producing higher quality lint:

1. Grade of seed purchased: Quality lint cannot be produced from inferior seed.
2. Seed cleaning equipment: Type and settings of cleaning equipment determine types of trash that will be removed before the delinting process begins.
3. Sharpness of saws, roller settings, and velocity of air flow through linters saws: Such adjustments determine the type of cut that will be made and the degree of crushing of trash or hulls.
4. Lint cleaners: Lint cleaners may be used to remove hull pepper and ground trash not previously removed.

The first two stages are merely controls by the mill to assure the processing of uniform seed. These stages are not particularly affected by linters prices within a season.¹⁸

The last two stages of quality control are adjusted by many mills from season to season in response to prices and market expectations. It is in these stages that oil mills actually control the volume and quality of linters.¹⁹

The response of oil mills to changes in the market prices of linters creates a paradox in the relative quality of linters produced from a given supply of seed. Oil mill operators indicated that when the price of first cuts increased relative to second cuts, there was a tendency to try to obtain a heavier cut, or more first cuts, from the seed. The reverse would be true for a decline in the price differential. An increase in the volume of first cuts from seed results in some decrease in the average grade and reduces fiber content of second-cut linters, thus decreasing cellulose content. Most mills make the adjustments in cut, if any, at the beginning of a season after due consideration of the following factors: (1) Experiences of the previous season, (2) expectations during the current season, and (3) effects of the change on the daily mill operations. In brief, the mills seek the most efficient production of linters in relation to the entire mill operation, and not the most efficient production of linters per se.

The relationship of prices to the percentages of first-cut, second-cut, and mill-run linters produced from 1947 to 1957 are illustrated in table 18. The effect of change on daily mill operation is probably the most important factor influencing changes in the cut, as no close cause-and-effect relationship is indicated between prices and changes in the cut. The production of second cuts or chemical-grade linters has increased slightly since 1947 at the expense of both first-cut and mill-run linters.

The relative stability in the percentage of first cuts, second cuts, and mill runs indicates stability in mill practices from year to year. Of particular importance are the factors associated with the daily operation of an oil mill. Interviews with oil mill operators indicated that the determination of the cost of cutting linters from seed, or the cost of processing by cut is not normally made by mills. Detailed cost analysis requires an academic allocation of joint costs. On the basis of common practice, linters have to be removed from seed to produce oil and meal efficiently, regardless of cost.

¹⁸ The 1950-51 season was an exception, when the value of linters relative to other products of cottonseed was an important factor in purchasing seed.

¹⁹ Only 10 out of 38 oil mills and mill organizations representing groups of mills stated that market factors did not influence their cut of linters.

TABLE 18.--Cotton linters: Percentage of production by cut and average price, selected grades, 1947-57 seasons

Year beginning August 1	Production, first-cut ¹ linters	Price per pound, high ² grade linters	Production, second-cut ¹ linters	Price per pound, chemical linters	Difference, price high grade ³ and chemical linters
	<i>Percent</i>	<i>Cents</i>	<i>Percent</i>	<i>Cents</i>	<i>Cents</i>
1947.....	24.4	9.71	68.6	5.73	3.98
1948.....	23.6	7.89	71.1	2.85	5.04
1949.....	25.3	10.49	68.2	3.61	6.88
1950.....	28.2	22.00	65.0	14.19	7.81
1951.....	24.4	12.50	69.2	7.41	5.09
1952.....	24.8	12.00	68.8	4.33	7.67
1953.....	23.8	10.30	70.6	3.22	7.08
1954.....	22.4	8.17	71.6	2.77	5.40
1955.....	23.6	8.06	71.1	2.71	5.35
1956.....	23.5	9.14	71.9	4.38	4.76
1957.....	23.8	8.72	70.2	3.38	5.34

¹ Computed from reports by the Bureau of the Census.

² Compiled by the Cotton Division, AMS.

³ Average over the 11 seasons has been 5.85.

In addition to the factors mentioned, others must be considered in determining the percentage of cut that will be made, such as (1) machinery installed and available for use, (2) volume of seed to be handled per machine or unit of time, and (3) oil mill management's belief that purchasers generally would or would not pay the price necessary to cover the additional costs of modifying seed cleaning and delinting to produce high-quality linters. Within the limitations set by mill location, scale of operations, and type of mill equipment, the managements of some oil mills, however, do believe that it is profitable to produce the highest quality of lint feasible from the seed available.

The economics of volume of seed to be handled is usually of greater importance to the mill than the quality of linters. The result is a tendency to consider volume flow through equipment as more important than quality adjustment.

Direct sales of linters by oil mills to particular end users encourage the production of higher quality linters. Arrangements between oil mills and end users usually include the production of a limited range in quality of linters to meet the specifications of each end user. Volumes and prices are negotiated in various ways. The prime advantage in these arrangements is the reduced variation in market prices, supply, and other factors, for the producer as well as the end user. Possibilities of increased quality control and stability in operations of the producer as well as the end user can result from such arrangements, but they have not been practicable for most of the industry because many end users use only a small part of a particular mill's production.

The complex problem of quality and price in linters production and marketing is far from being resolved by oil mills and consumers of linters. However, increased knowledge of the problems and opportunities of producing a quality product to meet consumer requirements may lead to improvements in oil mill practices.

Linters Sales

Marketing of linters is undergoing a change, in which some oil mills are recognizing that linters are more than a nuisance material that must be cut off the cottonseed and sold to the highest bidder. This change is reflected in the fact that, within the limitations of

oil mill plant facilities and the ability of mills to control quality, the types of linters most profitable to mills are the types that dealers, brokers, or bleachers find easiest to market and that end users find most economical to use.

Linters sales practices vary greatly throughout the Cotton Belt, with the greatest contrast evident between the Southeast and the Far West. Throughout the Cotton Belt, first cuts are sold mainly to dealers who buy on their own account for sale to end users, or through brokers who act as marketing agents for buyers and sellers. Second cuts produced west of Texas are not sold direct to bleachers, as are most of the second-cut linters produced in other regions. Sales to bleachers are usually made on the basis of chemical analysis of cellulose content. In the West, direct sales create difficulties. Western oil mills are more distant from the domestic bleachers who are the principal customers for second-cut linters.

Since western mills pay higher freight rates on shipments to domestic bleachers than other producers pay, a higher percentage of western linters moves into the export market.

Recent freight rate increases have increased the importance of distance between the points of production and consumption. Prices in Los Angeles for linters of identical grade and staple during 1957 were lower by about 1 1/2 cents per pound than in Memphis, Tenn. This difference approximates the cost of shipping linters from Los Angeles to Memphis.

Favorable location for export is a factor of importance, since nearly one-third of all U. S. production of chemical-grade linters are exported. Premium prices offered by exporters over domestic bleacher bids in 1956-57 were largest in the western producing area.

The dominant role of dealers and brokers in the handling of first-cut linters rests on the services they perform. The dealers provide price and quality information on supplies available at oil mills and on the needs of buyers. Since different kinds of linters are not truly interchangeable, characteristic differences of lint are included within grades. The dealer's experience in quality evaluation is invaluable in orderly marketing. This is of considerable importance for both first and second cuts, as they are not actually sold until inspected and accepted by purchasers.

RESEARCH NEEDS AND OPPORTUNITIES

Seed Cleaning

Both felting and chemical-grade linters contain varying amounts of foreign material consisting of field trash left in the seed during ginning or in linters after delinting operations. Cottonseed cleaning machinery and linters cleaning machinery at cottonseed oil mills, bleachers, or other end-product manufacturing plants are used for removing trash that is enmeshed in the linters during harvesting and ginning. The amount of foreign material left in the linters is the basis for discounts at the point of sale.

The apparent need for improved seed cleaning as indicated by the previous factors is an oversimplification of the problem, because:

1. Historically, users have regarded linters as a cheap source of raw material, while oil mill operators were content to dispose of the product as produced.
2. Utilization of linters has developed around the products now being produced.

3. Linters prices vary more on account of factors relating to supply and demand than to differentials attributed to the degree of cleanliness.²⁰
4. Regardless of the degree of cleanliness, few mills have experienced difficulty in disposing of the linters produced, though the price may at times be less than production cost.
5. The linters operation is a relatively small item in the minds of most operators, and is usually considered of secondary importance to operating the oil mill at a high level of capacity. In other words, most operators know that a small variation in volume of cottonseed processed means more to total mill returns than considerable variations in the price of linters.
6. Most cottonseed cleaning equipment currently in use by oil mills has been amortized. Therefore, the cost of cleaning the seed is limited to operating and repair costs. New machinery or additional investment would, in most cases, increase present processing costs without any definable immediate gain in returns. Mills that receive additional returns for cleaner linters usually do more cleaning than normal.

The complex technical-economic problem is not insurmountable. The situation is not static because, as new harvest and gin methods are introduced, seed cleaning, and thus linters cleaning, problems are altered.²¹ Comments by industry representatives and developments in the field suggest feasible approaches:

1. Approaching product specifications vertically from the standpoint of both the raw material and processed product value through cooperative research and development work in production, processing, and marketing, rather than at one level, offers some opportunity. Although it is self-evident that it is better to keep trash out of a product than to remove it after it is incorporated into a raw material, it is the economic return from improved seed cleaning that will determine if, when, and how the trash from linters should be removed.

Under today's practices, seed cotton is cleaned at the gins and cottonseed is cleaned at the oil mills. Linters are cleaned at the oil mill and in many cases by the end user.

2. Standardization and increased attention to improved quality characteristics of the products of cottonseed will become more important if present levels of use of cottonseed products are to be maintained, and especially if market outlets are to be expanded. The long-term tendency toward increasing transportation costs in relation to the value of raw material, and rising quality requirements for end-use products are justification for continuing moderate research efforts to improve cottonseed cleaning equipment.

Economic factors to be considered in evaluating the technical-economic problems of cottonseed cleaning are:

1. A decreased supply of seed available for processing affects oil mill returns much more than anticipated increased returns from improvements in cleaning of cottonseed. The immediate prospects for cotton production are not favorable for new investment in byproduct processing, which has been operating considerably below capacity in most of the Cotton Belt. However, the long-term trend toward increased lint and seed production nationally will require the benefits of research and development for improvements to meet the continuing challenge resulting from progress.

²⁰ Considerable debate in the industry is generated from the fact that there is no grading system to provide for grade premiums as an incentive to mills to produce cleaner linters.

²¹ The most objectionable field trash to remove is sticks. This is a serious problem in the Southwest, where a portion of the cotton is harvested by hand snapping and machine stripping.

2. Under the most favorable economic circumstances with which the industry likely will be faced, there is a very narrow margin indicated for profits from new investment in improved seed cleaning. In other words, under today's economic relationships, the returns from improved cleaning methods may be in cents per ton while new investment is in thousands of dollars per plant. The economic gain would be significant if the economic mill size were in terms of millions of tons, but becomes exceedingly problematical for cottonseed oil mills of average size.

Cleaning linters after they have been cut from the seed is essentially the same as cleaning the seed, with the following exceptions:

1. Hull pepper from cutting the hull off the seed has been mixed with linters and is not a desirable component for linters used as a source of cellulose.
2. Large pieces of trash that are not removed from the seed before it is processed are crushed or broken in the linters cutting machines during the delinting operation.
3. Although the volume of material to be cleaned is considerably less (about 200 pounds per ton of seed), the physical nature of the material makes separation of trash and usable product technologically more difficult.

The economics of the cottonseed processing industry as a whole has necessarily limited research on this problem.

Limitations on the benefits to be derived from improved seed cleaning do not alter the fact that the potential competition for oil and meal markets between soybean and cottonseed processors requires an additional return for other products of cottonseed in general, and linters in particular. In chemical and felting uses, linters markets will be affected by the degree of cleanliness of linters. To maintain present markets, the efficient removal of field trash and hull pepper can be a contribution of research for which no specific monetary gain can be applied.²²

New Equipment to Remove Linters From Seed

The academic task of allocating production costs in the modern cottonseed oil mill producing the joint products oil, meal, linters, and hulls is further complicated by the fact that the oil mill operators do not as a rule allocate costs to particular products. These costs vary considerably by type of mill, scale of operation, and control of installed equipment, so that estimates of the cost of cleaning seed and cutting, cleaning, and baling linters may vary from 1 to 3 cents per pound. The true cost is believed to be close to 3 cents per pound for the average mill. With no standard for comparing a possible new operation with the present methods, it has been impossible to determine the economic utility of improvements in cleaning. Various physical and chemical methods for removing linters from seed have been suggested as possibilities, but the low level of possible gain has made endeavors of this type of doubtful economic feasibility.

End-Use Product Equipment

Machinery to handle linters better for fibrous end uses also has been proposed, but again the economic margin plus the relatively small volume of product to be handled per machine has restricted research effort.

Products and production methods utilizing linters have not changed substantially over the years. Recent innovations using nonagricultural raw materials for products formerly made from linters have developed interest in improving the quality of linters products.

²² The Southern Utilization Research and Development Division of the Agricultural Research Service is now conducting research to develop new machines for improved cleaning of cottonseed at gins and oil mills.

Available designs for new equipment to produce a felt or batting superior to that made by garnetting linters and cotton waste have not been adopted largely due to economic considerations. The possibility remains of developing a machine to produce better felts or batts than those produced from garnetts now in use. The major drawbacks to such developments appear to be:

1. By and large, felt products produced today adequately meet the balance between utility and cost requirements for standard products using linters. The standard product defies precise utility measurement because of time that must elapse before performance in use can be determined. The grades of particular waste fibers used and the comparatively low prices of these materials discourage the investment of funds and manpower to improve the utility of a product which will not be known until the product is in use for a considerable time.
2. Production of felts and batting from waste fibers and linters is a relatively low-cost operation in which the possibilities for improved returns may be significant only when the volume produced is substantial.
3. Despite the influx of new competitive materials and processes, industrial firms tend to continue to use raw materials and processes with which they are familiar.
4. Historically, the price structure of the industry is one in which raw material price variations, in relation to prices received for the product, have more influence on returns than processing costs. In this industry, fluctuations in raw material costs have been more of a problem in orderly and profitable processing than the organization of plant operations.

Chemical Modification of Linters for Chemical Uses

Nearly two-thirds of the domestic linters are used for producing chemical cotton cellulose, which may be further treated chemically to produce a wide variety of products. Cotton cellulose is used domestically and exported as linters pulp. Linters in chemical uses have been by no means the principal source of cellulose in recent years. The increase in the volume of production and the quality improvement in cellulose derived from woodpulp have been substantial. In uses where the principal basis of competition is price, woodpulp has become the standard source of raw material. With technological improvements in the purification of dissolving woodpulp, linters no longer have the clear-cut quality advantage that they once had.

Recent progress in the use of linters in rag-content papers is a good illustration of how research and development have contributed to increased utilization of linters.

Direct competition in many uses for cellulose and cellulosic derivatives is coming from nonagricultural raw materials. The increased use of phenolic resins, polyethylene, polystyrene, melamine, and urea in plastics has been greater than the increased use of cellulose in plastics in the late 1950's.

Developments since 1956 indicate that cellulose plastics have desirable characteristics in some end uses which are not met by the newer plastics. Nevertheless, the most serious obstacle to a larger market for cellulose plastics has been the relative cost of modification as compared to the cost of noncellulosic plastics.

Different grades of cellulose acetate cost from 40 to 50 cents per pound in 1958. The higher chemical compounding required in producing acetate butyrate placed this material at about 60 cents per pound, while the etherification of cellulose resulted in a price of about 70 cents per pound. With competitive raw material prices ranging from 20 to 50 cents per pound, chemical manipulation in plastics seems to result in prices that favor the noncellulosic groups.

The primary use of linters pulp in high-tenacity rayon or acetate fiber continues to offer possibilities for chemical research to provide competition with the noncellulosic fibers. High-tenacity rayon, which competes in many end uses with nylon, is a type of cellulosic in which the characteristics of linters for many years were preferred over those of dissolving woodpulp.

In the future, industrial use of linters as a basic raw material in cellulosic products will depend primarily upon:

1. The particular characteristics for end uses may be the determining competitive factor. The growth of sales of colored telephones has created an expanding market for cellulose plastics because of linters superiority in producing pastel-colored plastics and because of its higher impact strength.
2. Continued research and development in products currently containing linters as a raw material.
3. Maintenance of a sufficient and stable supply of linters to meet market demand. Availability of supply is a serious limitation to linters as a raw material. Interviews with producers and users of chemical pulp indicated that considerations of long-run availability of a raw material in relation to expected needs is a key factor in the decisions of users to switch from one raw material to another. Expansion in dissolving woodpulp capacity over the last 5 years and projected growth through 1960 can be expected to limit future rises in the prices of chemical-grade linters. Dissolving woodpulp production in recent years has grown at approximately the same rate as the total market for cellulose pulp.

Current and projected price and volume considerations in the market for wood cellulose and cotton cellulose indicate that maintenance and expansion of linters use as a chemical cellulose raw material would be best served by research and development in quality control. The need is for (1) progress in providing the cleanest raw linters possible, which is limited not by technological problems alone but mostly by economic considerations, and (2) the improvement in and the maintenance of desirable linters characteristics in chemical processing. The first of these factors concerns the cottonseed industry directly, and the second, the research staffs of producers of cotton chemical pulp.

Analysis of comments and data obtained from industry and of other data indicates that linters will continue to be at a disadvantage in any market for long-term development in which stability in supply and price are vital in competition. Furthermore, research to exploit different quality characteristics and the maintenance of these characteristics in the marketing of linters as a raw material cannot be overemphasized as a basis for market expansion or maintenance.

Chemical Modification of Linters for Use as a Fiber

The successful development of noncellulosic fibers that compete with cellulosic fibers has indicated the possibilities and opportunities of maintaining or increasing the use of cellulosic fibers through chemical modification.

One drawback to this development is the cost of chemical modification. Known methods indicate that the additional costs of some finished products may be beyond the economic margin of feasibility. This may be illustrated in the use of linters in felting. In felting products, linters are desired for their resiliency and staple, and these characteristics must be considered together. The problem then revolves around these general conditions:

1. Chemical modification to improve resiliency must not decrease the utility of the fiber by increasing the difficulty of use occasioned by shortening staple length. That is, increased resiliency per se would not necessarily

increase the utility of the fiber if the process increased the problem of using a short staple fiber to make a felt or batt.

2. Price is the primary judgment factor in consumer purchases, and there is now no consumer measure of the utility of a fiber mattress using a linter mix that enables producers to compare modifications, except from value judgments based on past experience. Foam rubber and foam plastics have introduced new competitive factors based on certain characteristics, but even with these new materials, there is no satisfactory measure of performance in use. Research and development of substitute materials will continue to reduce the price advantage currently held by the fiber products, while developmental research to improve the utility of linters is practically nonexistent. The fiber product is the standard with which the new products are being compared in the development of superior products.
3. Competitive products which are being introduced are higher priced than the linter-waste products, but increased production and research development are aimed toward reducing this price disadvantage. As prices of new materials become competitive, the market potential of linters and cotton waste in end-use products will depend more and more on utility.

The conditions described suggest the benefits of applied research that might result from development of basic knowledge of partial chemical modification of linters and cotton fibers. Partial chemical modification is suggested for technical and economic reasons, because known chemical treatments would apparently increase the costs of the raw materials used beyond the point of economic utility. Major opportunities for improving the utility of products made from linters lie in (1) attaining a higher degree of resiliency, which cannot now be measured, (2) minimizing the processing drawbacks of the short linters fibers, (3) reducing foreign matter of raw linters to a minimum, and (4) holding chemical modification costs to levels that will keep linters competitive.

These restrictions increase the improbability of outstanding achievements in chemical modification. Also, the volume potential may not be large enough to offer the economy of scale which is so important in the chemical processing industry.

